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MARICOPA COUNTY, AN INTERIM REPORT ON A SOLID WASTE DEMONSTRATION PROJECT

John Carollo Engineers
Lafayette, California

1969

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MARICOPA COUNTY

An Interim Report
on a
Solid Waste Demonstration Project

Prepared by John Carollo Engineers
under Grant No. DO1-UI-00039

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
Environmental Control Administration
Bureau of Solid Waste Management
1969

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FOREWORD

An estimated 900 million pounds of solid wastes of all types are produced in the United States every day. What to do with these solid wastes, how to dispose of them without needlessly endangering public health and welfare, and how to recover and reuse valuable materials now "thrown away" are among the most challenging and perplexing of current national problems. Because of lack of suitable planning, interest, and public understanding, these problems have reached such proportions that nationwide attention is demanded and action for the development of adequate solutions must be taken.

Intensified action concerning these problems was made possible by the Solid Waste Disposal Act, Title II of Public Law 89-272, which was signed by the President on October 20, 1965. This legislation directs the Secretary of the Department of Health, Education, and Welfare to initiate, encourage, and support a national program aimed at discovering and evaluating better methods of coping with the solid waste problem.

The Secretary is authorized (1) to conduct and support research on the nature and scope of the problem, on methods of more safely and efficiently collecting and disposing of solid wastes, and on techniques for recovering from solid wastes potentially valuable materials and energy; (2) to provide training and financial and technical assistance to local and state agencies and other organizations in the planning,

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development, and conduct of solid waste management problems; (3) to encourage and support projects that may demonstrate new and improved methods of solid waste collection, handling, and disposal.

To carry out these responsibilities, the Bureau of Solid Waste Management was established. Among the responsibilities with which the Bureau is charged is that of providing grant support for demonstrations relating to the development and application of new and improved methods of solid waste collection, storage, processing and ultimate disposal; and also for studies and investigations that may lead to a demonstration of improved disposal practices, or may provide solutions for regional or national solid waste disposal problems. Associated with this is the responsibility of collecting and making available by appropriate means the results of, and other information pertaining to, such federally supported demonstrations, studies and investigations.

Accordingly this report has been reproduced to disseminate as widely as possible the latest available information and findings of a project that had received grant support from the Bureau of Solid Waste Management. It is hoped that it will provide those working in this field with useful information that will be of assistance in developing approaches in the solutions of their solid waste disposal problems.

--RICHARD D. VAUGHAN, *Director*
Bureau of Solid Waste Management

ABSTRACT OF STUDY AND INVESTIGATION GRANT NO. DO1-UI-00039

TITLE: Maricopa County-wide Solid Waste Disposal

GRANTEE: Maricopa County Health Department

PROJECT DIRECTOR: Joseph J. Weinstein, M. C. E., Director
Division of Environmental Health Services
Maricopa County Health Department
1825 East Roosevelt
Phoenix, Arizona 85006

ESTIMATED TOTAL PROJECT COST:	$80, 955
GRANTEE'S SHARE:	$26, 985
FEDERAL SHARE: (by year of project life)	$30, 000 [01] $ 9, 970 [02] $14, 000 [03]

PROJECT STARTED: December 1, 1966 **PROJECT ENDS:** March 31, 1970

OBJECTIVES: ~~To~~ The project demonstrate how new or improved solid waste management techniques could solve a regional solid waste problem by developing a solid waste disposal system and plan for county-wide reference and use, and by developing a protocol and timetable for putting the plan into effect.

PROCEDURES: Types and quantities of solid wastes now being produced in Maricopa County, will be determined, and existing disposal methods identified. The interrelationship between current collection practices and disposal practices will be studied. Estimates of population growth to the year 2000, and parallel projected increases in solid waste production will be made. An analysis will be made of possible solutions to the solid waste disposal problem of the county. A recommended county-wide solid waste disposal plan will be developed. This will take into account necessary funding arrangements, recognize and recommend required modifications of law, and describe needed intergovernmental cooperative agreements and other methodology which will assure a feasible plan.

The firm of John Carollo Engineers, Phoenix, Arizona, is providing consulting engineering services and is responsible for attaining a majority of the project objectives. Engineering and other personnel of the County Health Department are contributing to the study by making supplementary surveys of the availability and suitability of certain land for landfill purposes, and conducting topographic and soil exploration studies as needed.

JOHN CAROLLO ENGINEERS
Phoenix, Arizona Lafayette, California El Paso, Texas

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Reply to:
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PHOENIX, ARIZONA 85012
AREA CODE 602 265-4796

April 22, 1968

Mr. Joseph J. Weinstein, Project Director
Director, Division of Environmental Sanitation
Maricopa County Health Department
1825 East Roosevelt Street
Phoenix, Arizona 85006

Dear Mr. Weinstein:

With this letter we submit one hundred fifty copies of our Report on Solid Wastes Disposal for Maricopa County.

We hope that the representative of each of our twenty-one clients will consider this a personal letter expressing our appreciation for his cooperation in this study.

The assignment has taken more than a year to complete. We have analyzed all the published data we found on solid wastes haul and disposal to determine how it could be applied to Maricopa County problems. Study trips were made throughout Maricopa County and to Tucson; El Paso; Houston; Boston; and Los Angeles, Riverside, and Orange County, California.

Suggestions are included in the Report for interim action prior to 1970. During this interim period some haul and disposal practices can be improved without major organizational efforts.

Dedication and effort will be required to implement the 1970-1980 regional programs in the twenty months remaining. We are available for consultation on this Report with each of the participating agencies.

Very truly yours,

JOHN CAROLLO ENGINEERS

John A. Carollo
John A. Carollo, Partner
No. 616

Maurice L. Malick
Maurice L. Malick, Engineer
No. 2198

JAC/MLM/lc

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SOLID WASTES DISPOSAL REPORT

MARICOPA COUNTY

STATE OF ARIZONA

1968

AGENCIES PARTICIPATING IN THE STUDY AND REPORT:

City of Avondale
Town of Buckeye
City of Chandler
Town of El Mirage
Town of Gila Bend
Town of Gilbert
City of Glendale
Town of Goodyear
Maricopa County
City of Mesa
Town of Paradise Valley
Town of Peoria
City of Phoenix
City of Scottsdale
Town of Surprise
City of Tempe
City of Tolleson
Town of Wickenburg
Town of Youngtown
Salt River Maricopa-Pima Indian Community
United States Department of Health, Education, and Welfare, Public Health Service

Project Director: Mr. Joseph J. Weinstein
Director of Environmental Sanitation
Maricopa County Health Department

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PREFACE

This study and report was initiated through the foresight of Joseph J. Weinstein, Director of Environmental Sanitation, Maricopa County Health Department, Phoenix, Arizona. The Maricopa Association of Governments supported the program through the efforts of their Standing Committee on Solid Waste Disposal.

This study and report was financially aided through a Federal grant of two-thirds of the project cost from the Bureau of Solid Waste Management, Environmental Control Administration, Consumer Protection and Environmental Health Service, Public Health Service, U. S. Department of Health, Education, and Welfare.

The report is intended to provide organized data on solid wastes haul and disposal with particular reference to Maricopa County and its cities and towns. Regional programs proposed herein are for specific conditions in these regions, but the methods and data may be of interest to others concerned with similar programs.

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ACKNOWLEDGMENTS

We appreciate the special efforts and help of our clients who provided data, made special tests, and reviewed our interpretations of data submitted by them.

Information was contributed by others, expert in their specialties, and we acknowledge their substantial contributions:

Mr. Kenneth H. Thompson, City Manager,
Prescott, Arizona

Mr. Tom Price, Superintendent, Sanitation Division,
Tucson, Arizona

Mr. George Dieter, Public Works Director,
El Paso, Texas

Mr. William Zaun, Disposal Engineer, Orange
County, California

Mr. Gerry Vaughn, Manager, Lonestar Organics
Company, Houston, Texas

Mr. Roger McKillips, Assistant Director, Public
Works Dept., Houston, Texas

Mr. Lester A. Haug, Deputy Assistant Chief Engineer,
County Sanitation Districts of
Los Angeles County, California

Mr. Frank R. Dair, Division Engineer, County Sanitation Districts of Los Angeles
County, California

Mr. George Hubbard, Public Services Director,
Riverside, California

Parks and Sons (Private Firm Collectors), Youngtown,
Arizona

SUMMARY

MARICOPA COUNTY SOLID WASTES DISPOSAL REPORT

1968

SECTION 1 - INTRODUCTION

The purpose of this study has been to gather and analyze records of solid wastes haul and disposal data and to prepare a feasible solid wastes disposal plan for Maricopa County.

This Report is prepared for Maricopa County, the incorporated cities and towns within the County, the Salt River Pima-Maricopa Indian Community, and the United States Public Health Service.

In 1960 one-half of Arizona's population lived in Maricopa County, 8.1 percent of the State's land area. Yet the average population density of Maricopa County is only 72 persons per square mile.

Five adjacent cities in the County are those exceeding 30,000 population. These Major Cities are Phoenix, Scottsdale, Mesa, Tempe, and Glendale. They represent 80 percent of the County population on less than 5 percent of the County's land area.

The Metropolitan Study Area (Plate I-P5, Page S 1-7) is contiguous areas of Major Cities (over 30,000 population), Minor Cities and Towns (under 30,000, incorporated), the Salt River and Fort McDowell Indian Reservations, and interspersed County areas. It is in the Metropolitan Study Area that typical solid wastes disposal problems are developing in relation to large concentrations of people, commerce, industry, and agriculture.

Isolated, smaller towns like Buckeye, Gila Bend, and Wickenburg have been unable to finance adequate disposal programs.

This Report includes regional disposal programs for the 1970-1980 decade. Programs are more generally outlined for the decades 1980-1990 and 1990-2000.

Terminology is proposed for use in the County. Solid wastes include "rubbish," "garbage," "trash," and all solid discards from residential, commercial, industrial, agricultural, construction, and demolition sources. Solid wastes include those items which, technically, are plastics. Refuse includes solid wastes and those solutions and slurries not acceptable at wastewater treatment plants.

Special wastes commonly disposed as refuse in Maricopa County include dead animals, pathological wastes, sewage residue, abandoned vehicles, chemical wastes, radioactive wastes, explosives, and smoldering combustible solids.

SECTION 2 - CURRENT SOLID WASTES DISPOSAL METHODS

Generally, disposable solid wastes result from useful production, and the amounts are commonly reduced by salvage and disposal on site.

Contained and loose residential wastes are usually collected by municipal or private collector firm trucks. Individuals haul some residential wastes to disposal sites and create some problems by doing so.

Roadway litter is usually hauled by public agencies' trucks. Commercial solid wastes comprise nearly one-half of the disposable solid wastes. Only unusual items create disposal problems; usual commercial wastes blend with residential wastes in sanitary landfills.

Industrial and commercial solid wastes are usually collected together. Demolition and construction wastes are usually not accepted at municipal disposal sites and are buried, where solid fill is beneficial, by the contractors creating these wastes. Manufacturing solid wastes are the industrial wastes usually accepted at municipal sanitary landfills where they present few special problems.

Agricultural wastes create problems when stored. Sight, odor, and pest problems arise where decaying melons or lettuce are exposed. Cattle feeding pens and dairies accumulate manure piles which harbor flies and are odorous. Most agricultural wastes are disposed on the farm land, but increasing use of pesticides is expected to require disposal of vegetable wastes isolated from productive land.

Collection equipment includes standard vehicles: pickup trucks, station wagons, trailers, etc. Specialized collection equipment includes closed trucks for collection, compaction, and haul. An alternate system uses trains of collection trailers which are emptied into a large compactor truck for more efficient haul. Volume reduction at the collection point is achieved by brush chippers, stationary compactors, on-site incinerators, and power saws.

Fluctuations in kinds and amounts of solid wastes may adversely affect disposal operations. Surges in waste production are usually dampened on site; collection practices and schedules create surges at the disposal site. For example, once-a-week collections of brush create a peak daily tonnage rate and an adverse quality change. A peak hour occurs when all collection crews complete working shifts together. A last hour peak hour imposes a special problem at a sanitary landfill where the surge must be spread, compacted, and covered with earth before quitting time. Large receiving bins are required at incinerators.

Improper disposal of solid wastes on land may contaminate water supplies and the air. Air pollution also results from open burning and from improper use of incinerators. Insanitary open dumps and burning dumps are still common in this nation.

Sanitary landfilling is the only method available on land as a sanitary disposal method for all solid wastes. Sanitary landfilling is more efficient where average haul distance is a minimum and daily tonnage is large enough to support investment in large items of equipment. Sanitary landfilling is regulated by both the State of Arizona and Maricopa County.

Engineering and cost records are inadequate, nationally and in this County, to provide the data necessary for good management and planning. Phoenix records are above average in this relation.

Incineration on site is commonly practiced to reduce volume of wastes, destroy contaminated materials, destroy papers for security, and cremate bodies. Municipal incinerators are properly used to reduce the volume of solid combustible wastes where sanitary landfill sites are so remote as to cause prohibitive haul cost. Air pollution control devices add substantially to incineration costs as control standards become more strict.

Modern solid wastes composting plants are unprofitable. They are properly classed as salvage plants because their purpose is to salvage paper, rags, metal, and glass. Although some plants have produced compost successfully, there was usually no adequate market for compost.

Sound principles of composting plant management have not been applied at most plants. This has resulted in project failure technically, financially, or both. Composting is in a research and development stage. Premature attempts to apply the process commercially have created misconceptions of the purpose and potential of the technical process.

Where no demand exists for compost (and no substantial demand was reported anywhere in the United States), net weight reduction by "composting" is about 20 percent by salvage. Additional volume reduction by shredding is accomplished in the salvage process. But the cost of shredding is more than the resultant saving in haul and disposal cost.

Estimated disposal factors were developed for Maricopa County by salvage (composting), central incineration, and sanitary landfill at a loading rate of 300 tons per day:

	Land Acres	First Cost $/ton	Operating Cost $/ton	Disposal Cost $/ton
Salvage (composting)	5	2.91	4.01	6.92
Incineration	3	2.08	2.90	4.98
Sanitary landfill	40	0.78	0.90	1.68

Composting, like other salvage methods, has the appeal of conservation in the public interest. But where sanitary landfill can be practiced to reclaim disfigured land, the estimated cost differential, $5.24 per ton, excludes composting from consideration.

Incineration has been considered necessary for some large cities where excessive cost of haul to distant sanitary landfill sites can be avoided by use of central incineration. Thus lower system cost is an advantage of incineration in a few localities. Salvage of metals after incineration helps reduce the net costs. In some very special applications heat recovery from refuse incineration may provide revenue to partially offset the high costs of incineration.

Disadvantages of the incineration method include the following:

1. The facilities cannot accept all kinds of solid wastes.
2. A central location creates another truck terminal and adds to traffic congestion nearby.
3. Air pollution control devices have not been proven adequate on full scale plants in this country.
4. Neighbors of potential incinerator sites will probably seek injunctions to prevent construction there.
5. First costs, operating costs, and maintenance costs are all higher, in most cities, for the haul-incineration system than for the haul-sanitary landfill system.

Transfer stations are plants which receive solid wastes from collection vehicles and transfer those wastes to larger, more efficient long-haul vehicles. Their use is advantageous where the system cost is reduced by reducing haul cost more than the cost of transfer, about $1.00 per ton.

SECTION 3 - POPULATION GROWTH

Population trends in Maricopa County and its communities have been projected across the time period prescribed for this study, terminating in the year 2000.

SUMMARY OF POPULATION PROJECTIONS, IN THOUSANDS

	1970	1980	1990	2000
5 Major Cities (over 30,000)				
Phoenix	670	1,000	1,393	1,700
Scottsdale	70	110	155	200
Mesa	70	106	142	200
Tempe	65	95	130	180
Glendale	45	80	120	160
13 Minor Cities and Towns (under 30,000)	61	86	111	144
Selected, Unincorporated Places	28	65	104	136
Dispersed Population	161	197	240	280
Maricopa County	1,170	1,739	2,395	3,000

SECTION 4 - SOLID WASTES DISPOSAL OPERATIONS IN MARICOPA COUNTY

Municipal disposal operations in Maricopa County in early 196 include sanitary landfills, landfills, dumps, and burning dumps. They do not include incineration or salvage by composting. Grinding of food wastes with discharge into sanitary sewers is practiced by individual householders and businesses but not by municipalities through central grinders. Neither reduction of garbage by cooking nor dehydration of garbage for temporary storage is practiced. Rendering of animal bodies to salvage useful components is the basis for private firms operating in the County. Shredding of solid wastes is practiced by private salvage firms and municipal brush collection crews. Hog feeding of cooked garbage was practiced at 67 licensed locations in the County in February 1968. Salvaged automobiles are processed into a useful steel product at three plants in the County. Land reclamation, in conjunction with sanitary landfills, has been practiced to a limited extent but has, unfortunately, been generally neglected in the County.

Municipal collection of residential solid wastes is common to all cities and towns except Paradise Valley. Commercial solid wastes are generally collected by municipal forces; the major exception is Phoenix where non-City vehicles haul about one-half of all solid wastes delivered to City sanitary landfills. Paradise Valley, Sun City, and Youngtown are examples of communities whose solid wastes are hauled by a private collection firm.

Measurements and records of haul and disposal operations in Maricopa County are generally inadequate to provide a complete factual basis for analysis and management. Phoenix has a good basic record of disposal at three landfills, and this record provides the most reliable data for analysis and use in this study. During the twelve-month period from June 1966 through May 1967, 483,000 tons were disposed from an estimated population of 518,000 in Phoenix. Average day tonnage was 1,323. Maximum day tonnage was 2,136 or 61 percent above the average.

In relation to population, per capita annual tonnage was 0.93 and per capita average day was 5.1 pounds.

City of Phoenix trucks hauled 58 percent of solid wastes delivered to three Phoenix landfills.

Disposal of solid wastes was reported by eight communities or their private firm haulers:

Place	Pounds per Capita per Day
Phoenix	5. 1
Chandler	4. 1
Mesa	3. 2
Paradise Valley	4. 2
Scottsdale	3. 8
Wickenburg	4. 0
Sun City	2. 1
Tempe	3. 3

In Phoenix residential solid wastes amounted to 2. 8 pounds per capita per day and commercial, 2. 3. Tucson collects combined residential and commercial solid wastes at an average rate of 5. 2 pounds per capita per day; Los Angeles' rate coincides with the Pheonix rate.

Rates of production of residential, commercial, and industrial solid wastes are estimated for the present and future on a pounds per capita per day basis to be 2. 5 for Sun City and Youngtown, 5. 5 for Phoenix, and 4. 5 for all other urban areas in Maricopa County.

SECTION 5 - ANALYSIS OF SOLID WASTES DISPOSAL PROGRAMS IN MARICOPA COUNTY

Sanitary landfill is the only sanitary method for disposal of solid wastes on land. Disposal in water is not a practical consideration in Maricopa County. Disposal in air (by incineration) is feasible as an on-site method but is not needed as a municipal method. Where on-site incineration violates air pollution control regulations, sanitary landfill is a feasible, alternate disposal method.

Landfills, open dumps, and burning dumps are not satisfactory facilities for sanitary disposal on land.

Coincident with this study in 1967 commendable progress has been made in municipal disposal practices. About 86 percent of the County population is served by sanitary landfill facilities now. Eight communities are still using open dumps or burning dumps; they represent about 3 percent of the County population. About 11 percent of the County population is dispersed in rural areas where solid wastes collection service is not available.

In Maricopa County the practical aim should be to provide, by 1970, for sanitary landfill disposal of solid wastes produced by about 90 percent of the population. All communities and their urban fringe areas are included in that 90 percent. The 10 percent excluded is the rural, dispersed population for which collection and haul is expected to be impractical through 1969.

Existing regional disposal programs provide a basis for continued and expanded regional programs. Regional programs are the key to disposal facilities for smaller communities.

We concur with our consultant attorney that existing state law allows a city or town to operate a sanitary landfill at a location it determines. A public dumping ground location is much more restricted. State and County regulations provide regulation of dumps, sanitary landfills, incineration, and salvage operations.

SECTION 6 - A PLAN FOR DISPOSAL OF SOLID WASTES IN MARICOPA COUNTY

Disposal of solid wastes in Maricopa County will be a program of increasing magnitude throughout the three decades considered in this Report. Those decades are the periods: 1970 to 1980, 1980 to 1990, and 1990 to 2000. During that thirty-year period the population of the County is expected to rise to about 3,000,000 persons.

Rate for disposal of solid wastes in Maricopa County by the year 2000 is projected to be about 7,000 tons per day from residential, commercial, and industrial sources. This rate does not include a rate for agricultural solid wastes which fluctuates seasonally and is not directly related to population. The cost of haul and disposal of solid wastes in Maricopa County would be in excess of $10,000,000 per year at $4.00 per ton. When the annual cost reaches $10,000,000 per year, a one percent increase in efficiency will amount to a saving to the residents of Maricopa County of $100,000 per year.

Haul and disposal of solid wastes in the next three decades is a complex problem which demands careful analysis, development of the best possible long-range solutions, and continuing review of operations to maintain high efficiency.

The summation of problems related to accumulating solid wastes has a regional impact, and the program must provide regional solutions to the regional problems.

There is a probable relationship between exposed solid wastes and human disease incidence. But the reasons for sanitary disposal of solid wastes include five other significant ones, as follows:

1. to place wastes out of sight because they appear repugnant
2. to prevent odor nuisance from putrescibles
3. to reduce fire hazards
4. to reduce mechanical hazards
5. to free and preserve space in other areas.

Disposal programs must recognize and provide for disposal of five kinds of wastes:

1. Residential and institutional
2. Commercial and industrial
3. Construction and demolition
4. Traffic and recreational
5. Agricultural

Types 1, 2, and 4 above are included, quantitatively, in the disposal programs which follow. Some construction and demolition wastes are provided for in the disposal programs, but large amounts of solid, inert wastes will continue to be used to fill low ground.

Agricultural wastes do not accumulate in proportion to populations. They will continue to require disposal, seasonally, but disposal on fields may be discouraged because of pesticide concentrations. Termination of on-site agricultural solid wastes disposal would pose major disposal problems in Maricopa County which would not be solved by the programs recommended in this Report.

Projected solid wastes production is indicated in Table CP-T1 (Page S 6-9) for three decades in Maricopa County urban places.

Sanitary landfill is the least expensive and most effective method for disposal of solid wastes in the 1970-1980 decade in Maricopa County.

Haul and disposal by incineration of solid wastes from Phoenix was estimated to cost $6.89 per ton under conditions favoring the incineration method. Sanitary landfill cost in Phoenix averages $1.65 per ton at three sites. The difference, $5.24 per ton, represents the haul cost at which a sanitary landfill system would be equivalent, in cost, to the incineration system. Haul in collection trucks on Black Canyon Freeway costs Phoenix $0.07 per ton-mile. Thus haul distance on the freeway would be about 37 miles one way by collection packer trucks to a sanitary landfill site before the incineration system became competitive.

Transfer stations cost about $1.00 per ton to own and operate. Their purpose is to transfer solid wastes from collection trucks to more efficient long-haul vehicles. Where haul cost in collection trucks substantially exceeds $1.00 per ton, the use of transfer stations may be considered.

Provisions should be made for special wastes disposal to help prevent promiscuous dumping and dangerous practices. Certain specialized wastes can better be disposed at special sites and require special haul and disposal equipment.

Disposal by sanitary landfill is the basis of the 1970-1980 program. Eighty-eight borrow pits are listed with their locations in Maricopa County. Phoenix owns three sites and is currently studying twenty more, totaling about 3,100 acres of potential sanitary landfill sites. Glendale is studying seven sites totaling 757 acres for use by ten or more communities in their region. Scottsdale, Mesa, Tempe, and the Salt River Maricopa-Pima Indian Community are considering sites along the Salt River near the centroid of their combined populations.

Land area requirements are based upon an average capacity of 7,000 tons per gross acre. Computations for typical tracts indicated a capacity of 6,700 tons of solid wastes per acre for a 40-acre tract cut by a dry wash to 18,600 tons per acre for a 160-acre tract in similar topography. Compacted wastes would not exceed 30 feet in height.

A summary of land area requirements for sanitary landfill in Maricopa County is compiled in Table CP-T3 (Page S 6-27). Land area requirements are subtotaled for seven regions of Maricopa County and by decades to the year 2000. The following table summarizes those requirements:

SUMMARY OF LAND AREA REQUIREMENTS

1970-2000

	Decades			Total	
	1970-80	1980-90	1990-2000	1970 - 2000	
Regions (1)	Acres (2)	Acres (3)	Acres (4)	Acres (5)	Sq Mi (6)
Central	1,233	1,761	2,261	5,255	8.22
Southwest	14	18	22	54	0.08
West Central	80	120	164	364	0.57
Northwest	142	207	280	629	0.98
Northeast	274	371	500	1,145	1.79
Southeast	164	215	292	671	1.05
Wickenburg	8	9	10	27	0.04
Total	1,915	2,701	3,529	8,145	12.73

Regional programs for solid wastes disposal are proposed as the most efficient and least expensive means of providing sanitary disposal service to the smaller communities as well as the larger ones.

Sanitary landfill unit costs for owning and operating equipment are indicated on Plate CP-P2 (Page S 6-33). The unit cost at a filling rate of 100 tons per day is about four times the unit cost at 1,000 tons per day. Therefore the unit disposal cost can usually be lowered for each participant in a regional program where individual filling rates can be combined at one site. The disposal cost advantage is great where an independent's filling rate is less than 10 tons per day and may be included in a regional rate of 300 tons or more per day.

Haul costs tend to limit the size of regions. Minimum system cost is one aim for each participant in a regional haul and disposal system. Another aim is to provide service to areas otherwise excluded by excessive haul or disposal costs.

Seven regional systems are proposed within Maricopa County to attain an overall least cost haul and disposal program which can serve all urban areas in the County. Region names assigned in this study indicate the general direction each lies from central Phoenix, except for the Wickenburg region. (Each region includes adjacent parts of Maricopa County.)

Central region	Phoenix, Cave Creek, Carefree, and Paradise Valley
Southwest region	Gila Bend and Buckeye
West Central region	Tolleson, Avondale, Goodyear, and Litchfield Park
Northwest region	Glendale, Peoria, Sun City, Youngtown, El Mirage, Surprise, and Luke AFB
Northeast region	Mesa, Scottsdale, and Paradise Valley
Southeast region	Tempe, Chandler, and Gilbert
Wickenburg region	Wickenburg and Aguila

In the tabulation below, disposal site location, estimated tonnage, haul distance, and cost factors are indicated for each region for the 1970-1980 decade.

SUMMARY OF FACTORS FROM REGIONAL PROGRAM

1970-1980

Region (1)	Disposal Site Location (2)	Solid Wastes 1,000 Ton/yr (3)	Avg Haul Dist Mile (4)	Avg Haul Cost $/ton (5)	Avg Disp Cost $/ton (6)	Average System Cost $/ton (7)	Average System Cost $/year (8)
Central							
North 1/2	Greenway Rd at 19th Ave	366	12	1.08	1.32	2.40	878,000
South 1/2	Salt River at Central Ave	497	10	1.10	1.04	2.14	1,060,000
Southwest	Palo Verde	7.4	54	1.70	3.10	4.80	35,600
West Central	El Mirage at McDowell Rd	36.2	20	1.63	2.20	3.83	139,000
Northwest	107th Ave at Northern	87	12	1.16	1.40	2.56	224,000
Northeast	Country Club Dr at McDowell	156.5	13	0.75	1.25	2.00	313,000
Southeast	Interstate 10 at Warner Rd	53.4	15	1.18	1.60	2.78	149,000
Wickenburg	Section 4, T7N, R 5W	5	28	3.00	1.50	4.50	22,500

Column 2: Within one mile
Column 3: Average, 1970-1980
Column 4: Round trip

Maricopa County government participation in regional programs is required in several ways to attain the purposes of these programs. The Division of Environmental Services, Maricopa County Health Department should continue to give positive leadership in improving and extending collection, haul, and disposal services throughout Maricopa County.

One means foreseen for extending feasible sanitary disposal service to isolated urban areas is for Maricopa County to operate special long-haul equipment through a public works department limited to this activity.

Extension of collection services into areas previously not served may be accomplished by contracts based upon competitive bids or by use of franchised collection areas. Fringe areas may be served by extension of municipal services beyond their corporate limits. All means foreseen for extension of collection service into Maricopa County urban areas will require positive leadership at the County level.

Solid wastes disposal programs outlined for the two decades from 1980 to 2000 are quite general. Land area requirements are based upon successively less reliable distribution of population projections by regions. Seven thousand tons of solid wastes per acre is the capacity rate used in estimating land area requirements. By 1975 better data should be available for use in re-estimating capacity of specific sites.

Haul costs may be estimated more closely as additional freeways are opened for service and real haul time can be determined.

The Maricopa Association of Governments, Solid Wastes Subcommittee should coordinate efforts to establish uniform weighing, recording of engineering and cost data, and analysis of the data. These data are urgently needed for management and planning by each agency acting in collection, haul, or disposal of solid wastes.

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I-P3 Percent of Maricopa County Land Area in the Six Cities over 10,000 Population, 1965 and Percent of Maricopa County Population in the Six Cities over 10,000 Population, 1965 S 1-5
I-P4 Maricopa County, Arizona S 1-6
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TABLES

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I-T2 Solid Wastes Classified by Source and Combustibility S 1-14
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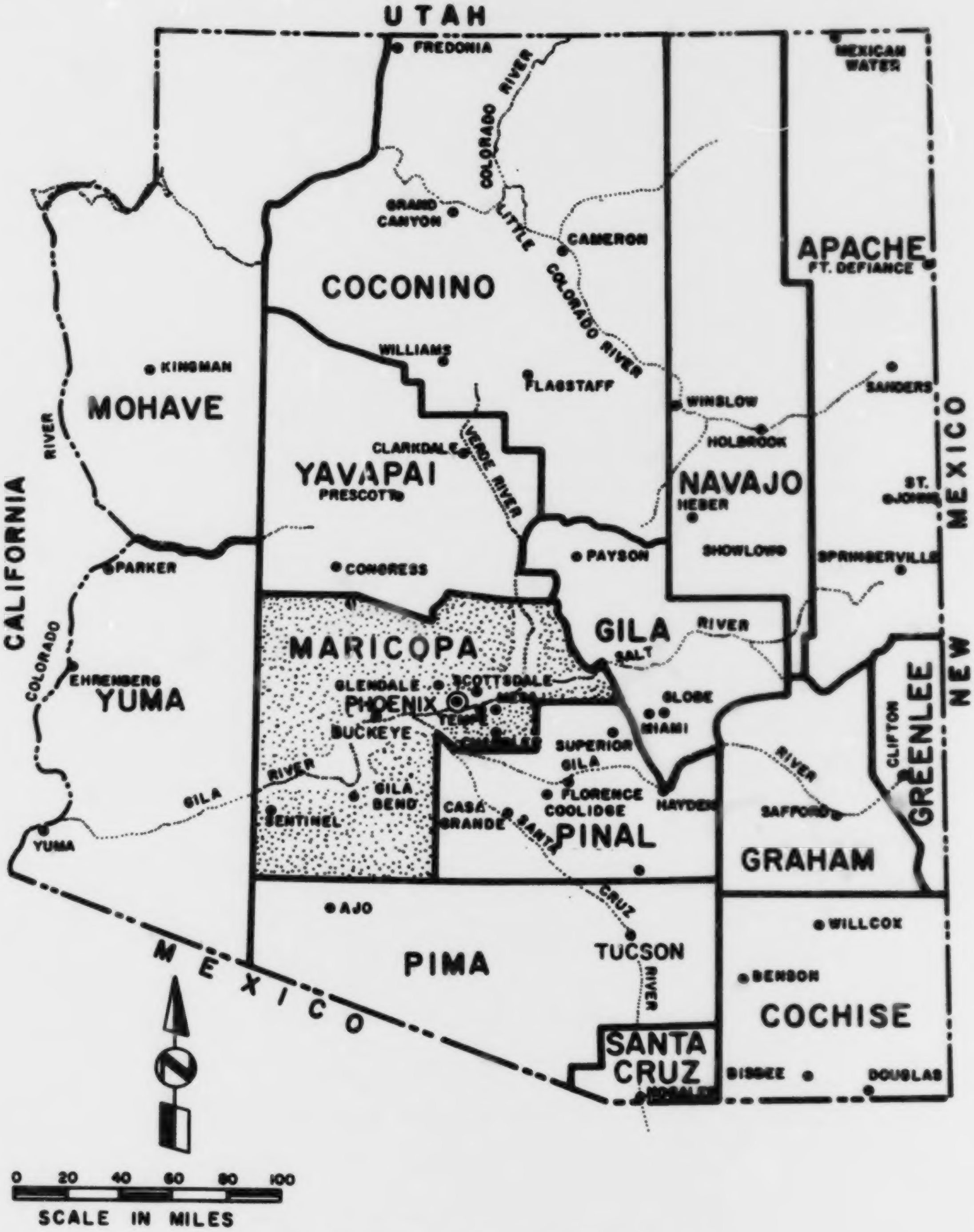
I-T4 Classification of Wastes to be Incinerated S 1-16
I-T5 Estimated Heat of Combustion from Selected Solid Wastes S 1-17

Plate I-P1


UTAH
FREDONIA
COLORADO RIVER
GRAND CANYON
LITTLE COLORADO RIVER
CAMERON
COCONINO
MEXICAN WATER
APACHE
FT. DEFIANCE
WILLIAMS
FLAGSTAFF
KINGMAN
MOHAVE
RIVER
WINSLOW
HOLBROOK
SANDERS
CLARKDALE
VERDE RIVER
YAVAPAI
PRESCOTT
NAVAJO
HEBER
ST. JOHNS
CALIFORNIA
NEW MEXICO
PAYSON
SHOWLOW
SPRINGERVILLE
PARKER
CONGRESS
COLORADO
GILA
RIVER
SALT
MARICOPA
GLENDALE
SCOTTSDALE
MESA
PHOENIX
TEMPE
EHRENBERG
YUMA
GLOBE
MIAMI
CLIFTON
GREENLEE
BUCKEYE
CHANDLER
SUPERIOR
GILA
RIVER
GILA
RIVER
GILA BEND
FLORENCE
COOLIDGE
HAYDEN
SAFFORD
SENTINEL
CASA GRANDE
SANTA
PINAL
GRAHAM
YUMA
AJO
CRUZ
WILLCOX
MEXICO
PIMA
TUCSON
RIVER
BENSON
COCHISE
SANTA CRUZ
NOGALES
BISBEE
DOUGLAS
0
20
40
60
80
100
SCALE IN MILES

STATE OF ARIZONA

MARICOPA COUNTY

SOLID WASTES DISPOSAL REPORT

SECTION 1

INTRODUCTION

PURPOSE

The purpose of this Report is three-fold:

- I To define the character and magnitude of the problem of disposing of solid wastes in Maricopa County, Arizona.
- II To report the present stage of development of disposal practices.
- III To present a feasible solid wastes disposal plan and system for County-wide reference and use to the year 2000.

AUTHORITY

Authority for this study and Report was established in an agreement between the County of Maricopa and John Carollo Engineers. The date of the agreement is March 20, 1967, and the time for completion is one year, terminating March 20, 1968.

SCOPE

AREA: The Report Study Area is Maricopa County, Arizona. The location of Maricopa County is indicated on Plate I-P1, a map of the

State of Arizona. The relative land areas and 1960 population of the fourteen counties of the State are represented in circular graphs on Plate I-P2.

Solid wastes accumulate, principally, as by-products of human activities. Where human activities are concentrated, solid wastes accumulate in astonishing variety and amounts. Plate I-P3 (Page S 1-5) indicates about 80 percent of the 1965 Maricopa County population was in the five adjacent Cities of Glendale, Phoenix, Scottsdale, Tempe, and Mesa.

Plate I-P4 (Page S 1-6) is a map of Maricopa County depicting the locations of high density populations (in the cities and towns), restricted low density areas (reserved as Indian reservations, National forest, or large military reservations), and other low density areas.

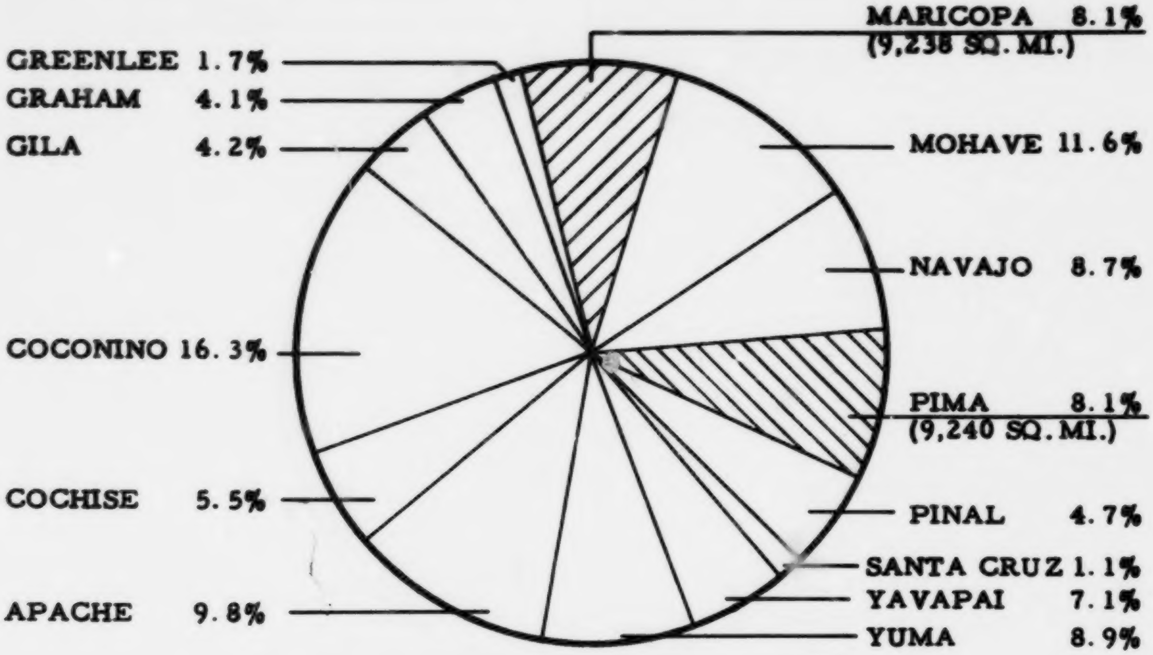
The foregoing considerations have prompted individual studies of potential growth of each city having a 1965 population in excess of 10,000. These studies led to the definition of the Metropolitan Study Area and its boundaries, as indicated on Plate I-P5 (Page S 1-7).

The Metropolitan Study Area is the origin of about 90 percent of Maricopa County's solid wastes. There is the largest, most complex, and most expensive disposal problem. There is the threat of contamination to the land, water, and air on which over 90 percent of the County's population must depend for survival. For these reasons this study and Report is concentrated on the Metropolitan Study Area.

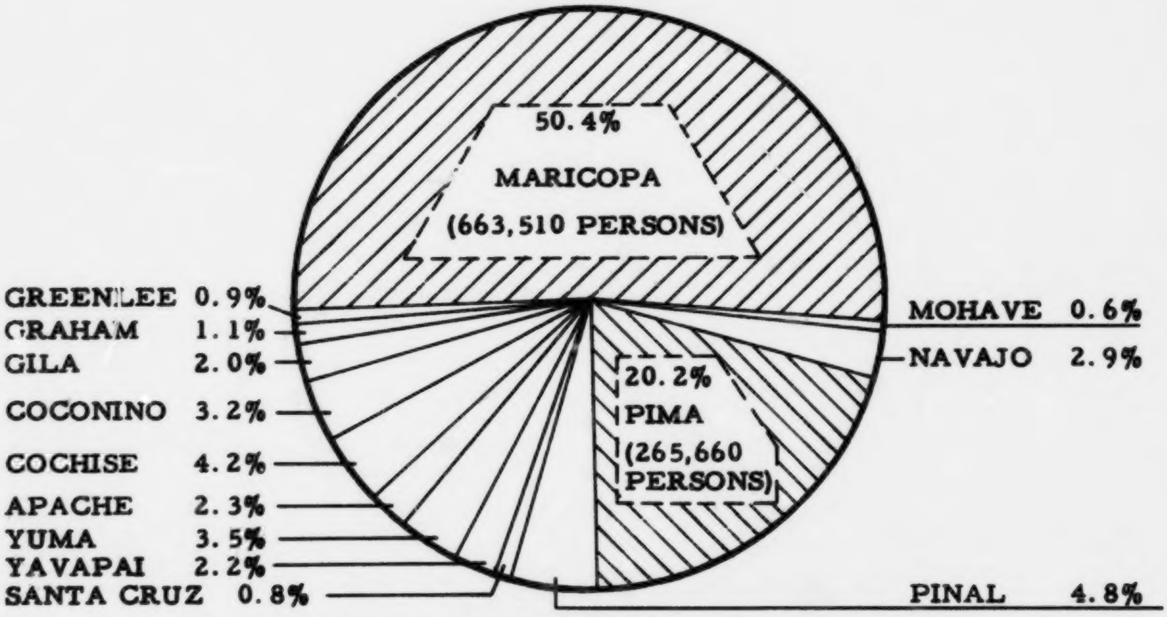
Isolated, smaller communities have enough solid wastes to pose continuing threats to their environments and, in addition, have lacked the means to provide adequate disposal facilities.

The Gila Bend study area is indicated on Plate I-P6 (Page S 1-8).

Plate I-P2

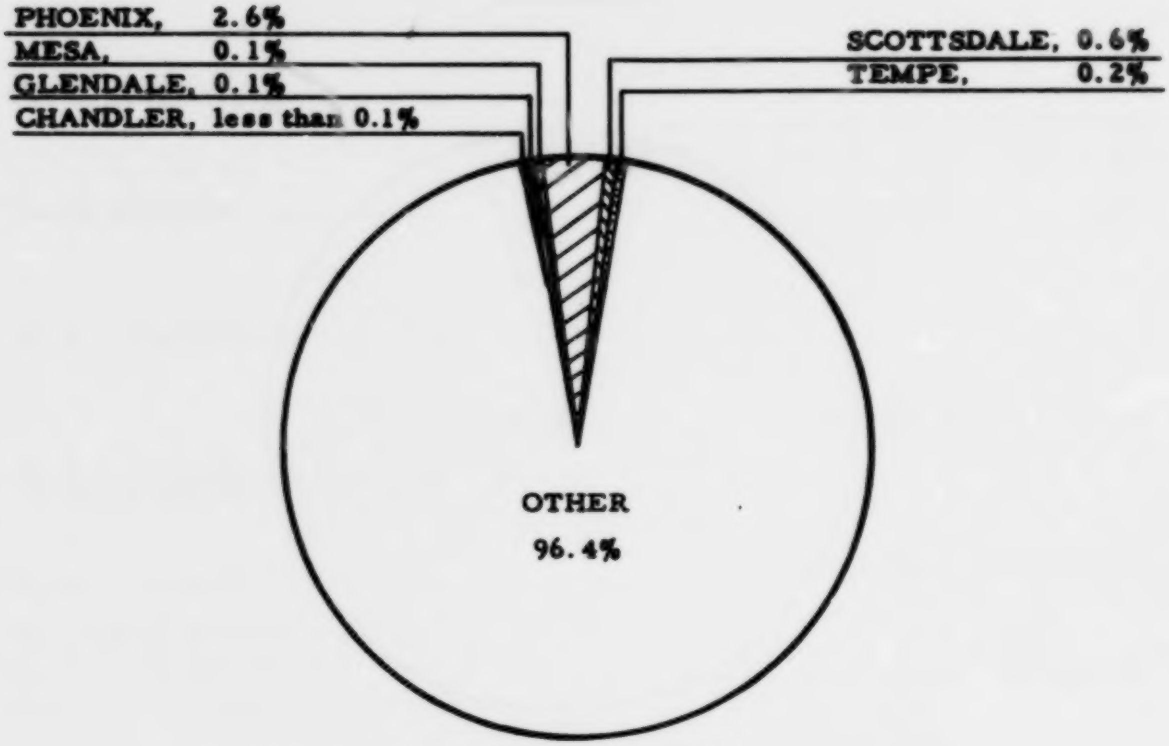


RELATIVE LAND AREA OF THE 14 COUNTIES
STATE OF ARIZONA
(113,562 SQ.MILES)

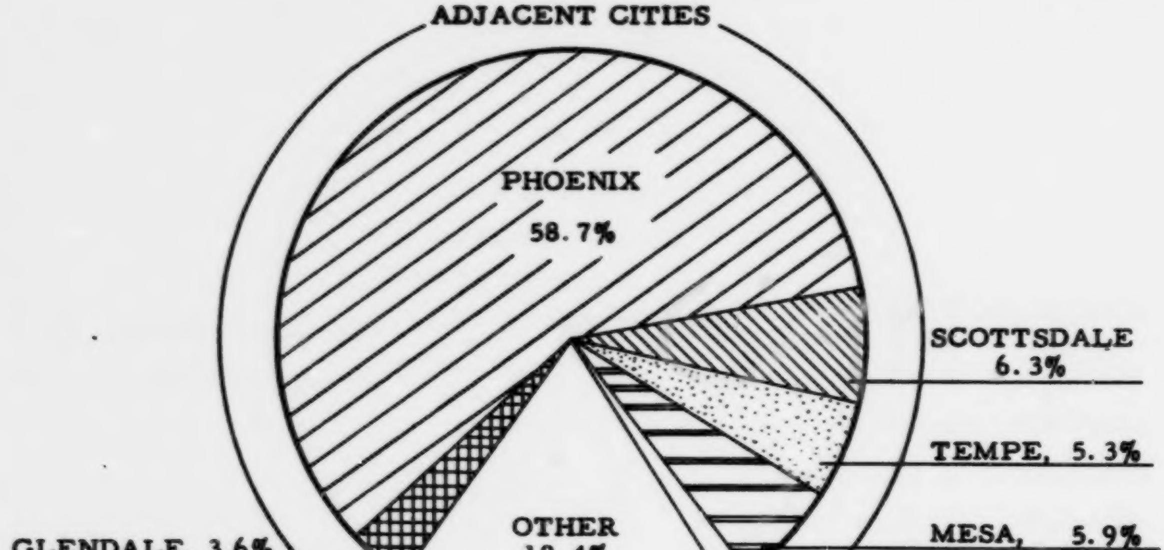


RELATIVE 1960 POPULATION OF THE 14 COUNTIES
STATE OF ARIZONA
(1,302,161 PERSONS)

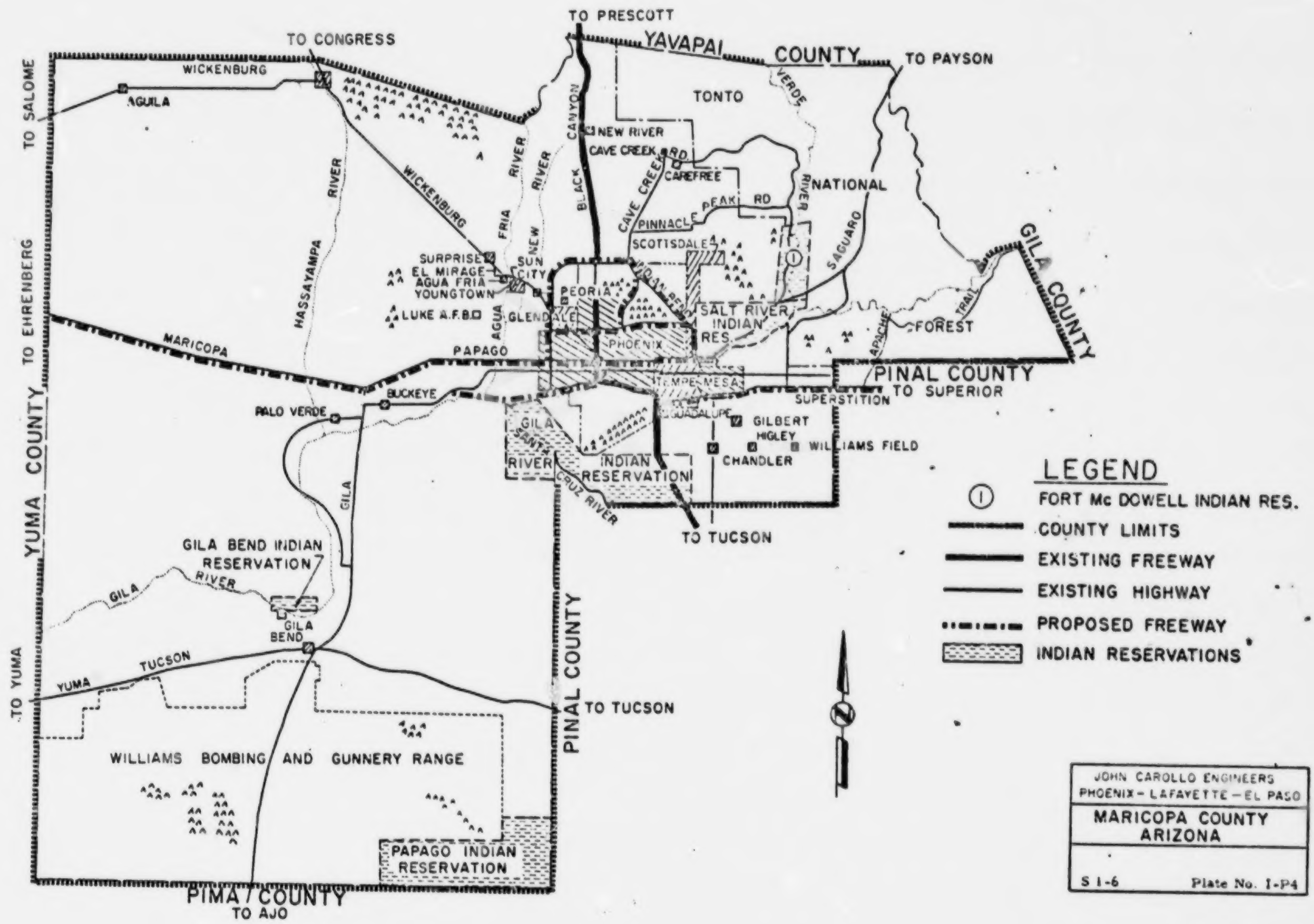
Plate I-P3



PERCENT OF MARICOPA COUNTY LAND AREA IN THE 6 CITIES OVER 10,000 POPULATION, 1965



PERCENT OF MARICOPA COUNTY POPULATION IN THE 6 CITIES OVER 10,000 POPULATION, 1965


TO PRESCOTT
YAVAPAI COUNTY
TO PAYSON
TO CONGRESS
WICKENBURG
AGUILA
TO SALOME
TONTO
VERDE RIVER
NATIONAL
FOREST
NEW RIVER
CAVE CREEK RD
CAREFREE
PINNACLE PEAK RD
CAVE CREEK
BLACK CANYON
FRIA RIVER
NEW RIVER
HASSAYAMPA RIVER
WICKENBURG
SURPRISE
EL MIRAGE
AGUA FRIA
YOUNGTOWN
SUN CITY
LUKE A.F.B.
AGUA FRIA
PEORIA
GLENDALE
SCOTTSDALE
INDIAN BEND
SALT RIVER INDIAN RES.
PHOENIX
SAGUARO
APACHE TRAIL
GILA COUNTY
PINAL COUNTY
TO SUPERIOR
SUPERSTITION
TEMPE
MESA
GUADALUPE
GILBERT
HIGLEY
CHANDLER
WILLIAMS FIELD
TO EHRENBERG
MARICOPA
PAPAGO
BUCKEYE
PALO VERDE
GILA
GILA RIVER INDIAN RESERVATION
SANTA CRUZ RIVER
TO TUCSON
YUMA COUNTY
GILA BEND INDIAN RESERVATION
GILA RIVER
GILA BEND
TO YUMA
YUMA
TUCSON
TO TUCSON
PINAL COUNTY
WILLIAMS BOMBING AND GUNNERY RANGE
PAPAGO INDIAN RESERVATION
PIMA COUNTY
TO AJO
N
LEGEND
① FORT Mc DOWELL INDIAN RES.
COUNTY LIMITS
EXISTING FREEWAY
EXISTING HIGHWAY
PROPOSED FREEWAY
INDIAN RESERVATIONS

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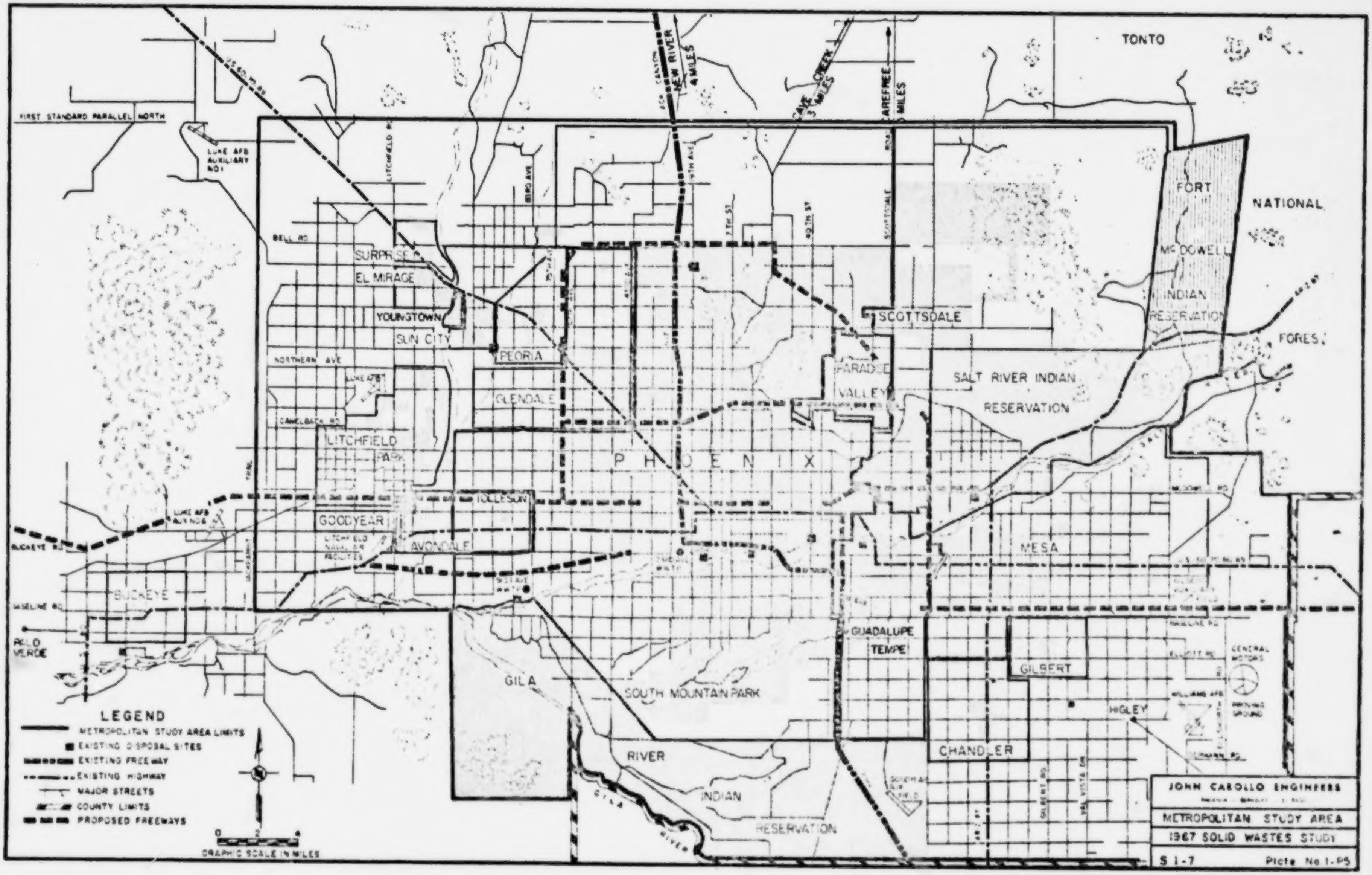
PHOENIX - LAFAYETTE - EL PASO

MARICOPA COUNTY
ARIZONA

S 1-6 Plate No. I-P4

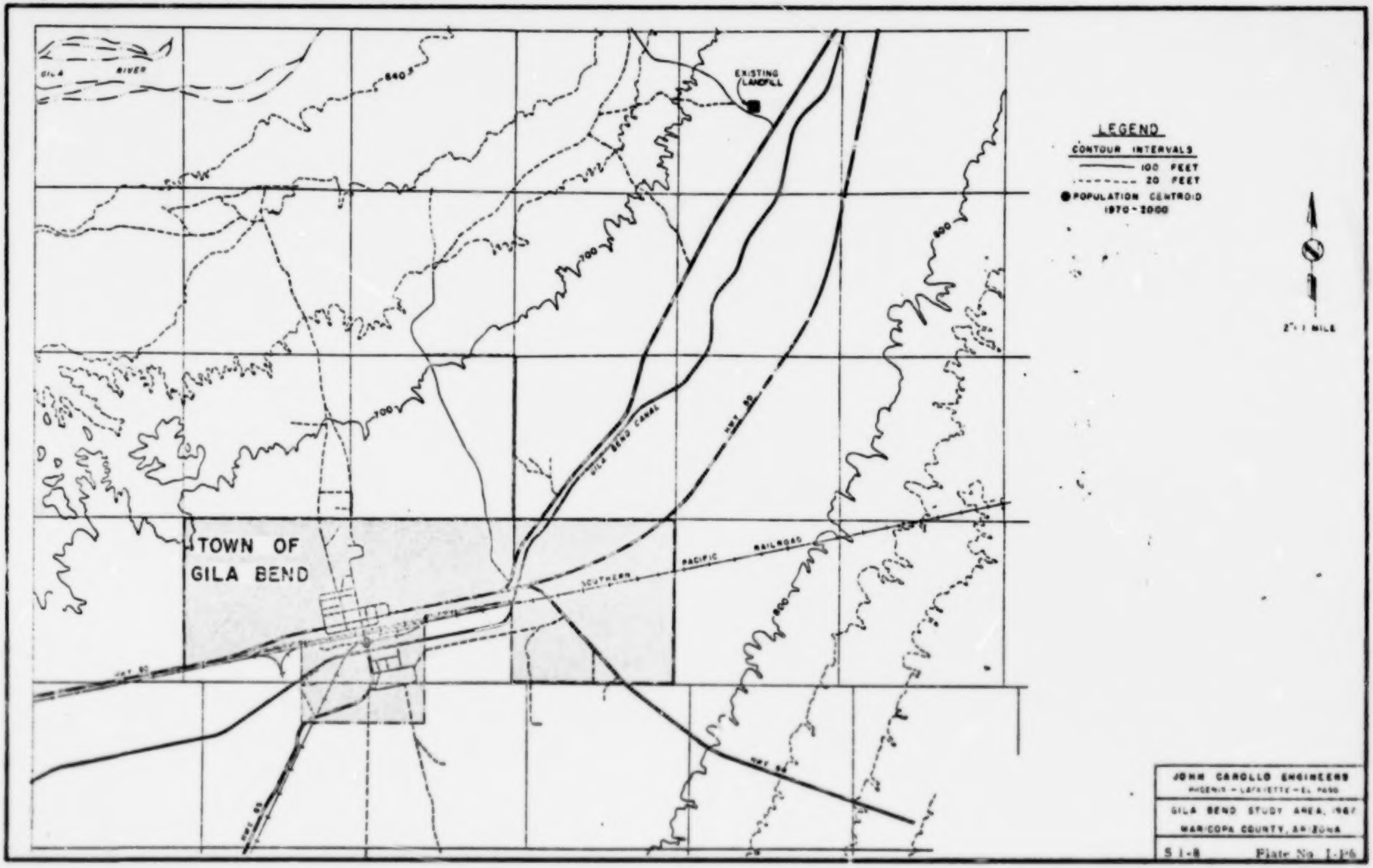

TONTO
NATIONAL
FOREST
FORT
McDOWELL
INDIAN
RESERVATION
SALT RIVER INDIAN
RESERVATION
SCOTTSDALE
PARADISE
VALLEY
CAVE CREEK 3 MILES
CAREFREE 5 MILES
NEW RIVER 4 MILES
FIRST STANDARD PARALLEL NORTH
LUKE AFB AUXILIARY NO 1
BELL RD
LITCHFIELD RD
SURPRISE
EL MIRAGE
YOUNGTOWN
SUN CITY
PEORIA
GLENDALE
NORTHERN AVE
LUKE AFB
CAMELBACK RD
LITCHFIELD
PARK
P H O E N I X
TOLLESON
GOODYEAR
AVONDALE
LITCHFIELD NAVAL AIR FACILITIES
BUCKEYE RD
BUCKEYE
BASELINE RD
PALO
VERDE
MESA
GUADALUPE
TEMPE
GILBERT
CHANDLER
HIGLEY
GENERAL
MOTORS
PROVING
GROUND
WILLIAMS AFB
GILA
SOUTH MOUNTAIN PARK
RIVER
INDIAN
RESERVATION
GILA
RIVER
LEGEND
METROPOLITAN STUDY AREA LIMITS
EXISTING DISPOSAL SITES
EXISTING FREEWAY
EXISTING HIGHWAY
MAJOR STREETS
COUNTY LIMITS
PROPOSED FREEWAYS
0
2
4
GRAPHIC SCALE IN MILES

JOHN CAROLLO ENGINEERS

METROPOLITAN STUDY AREA

1967 SOLID WASTES STUDY

S 1-7 Picte No 1-P5

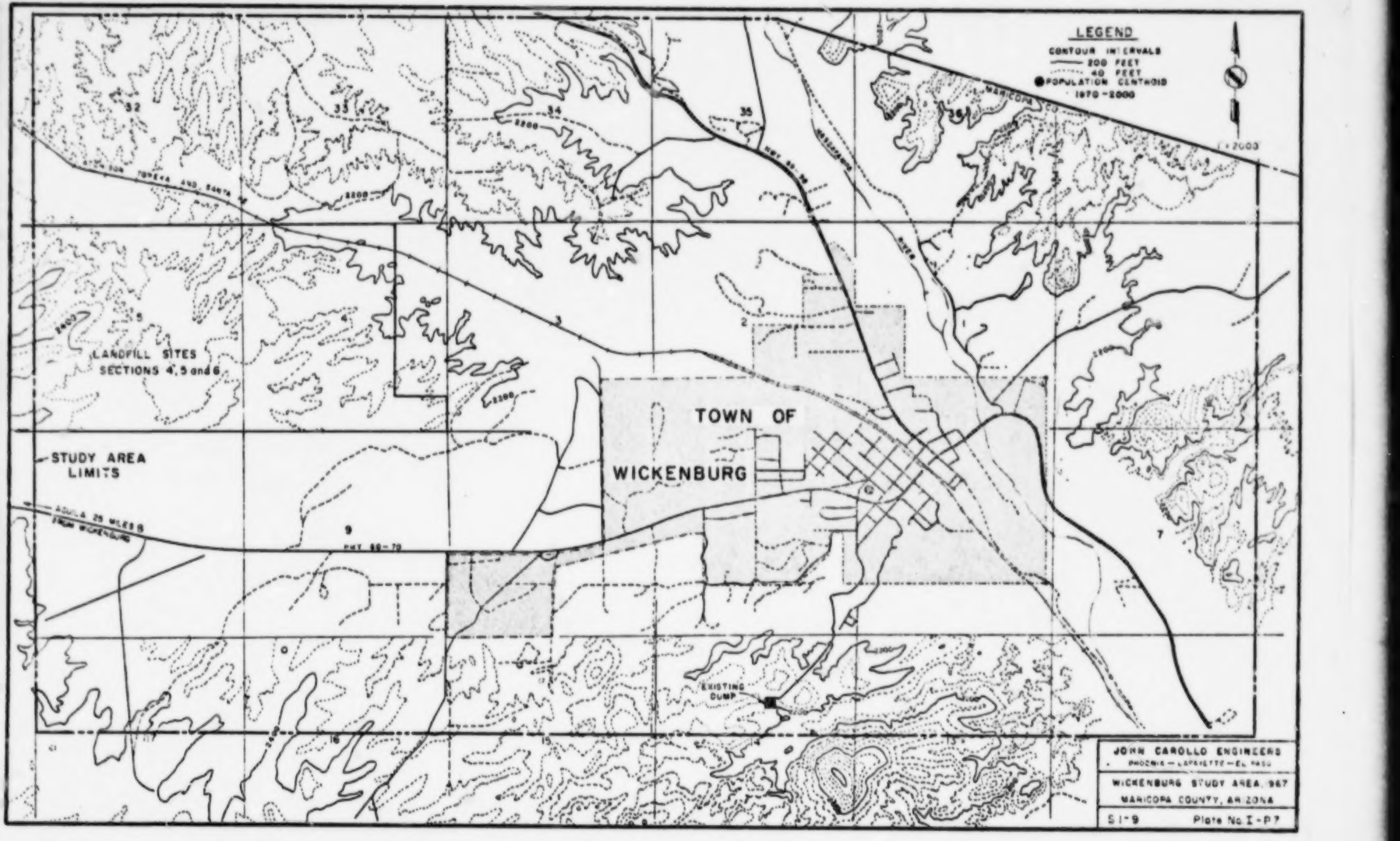


GILA RIVER
640
700
800
EXISTING LANDFILL
GILA BEND CANAL
HWY 80
SOUTHERN PACIFIC RAILROAD
TOWN OF GILA BEND
HWY 85
LEGEND
CONTOUR INTERVALS
100 FEET
20 FEET
● POPULATION CENTROID 1970-2000
2" = 1 MILE

JOHN CAROLLO ENGINEERS
PHOENIX – LAFAYETTE – EL PASO

GILA BEND STUDY AREA, 1967
MARICOPA COUNTY, ARIZONA

S 1-8 Plate No. I-16


LEGEND
CONTOUR INTERVALS
200 FEET
40 FEET
● POPULATION CENTROID
1970-2000
MARICOPA CO.
TOWN OF
WICKENBURG
LANDFILL SITES
SECTIONS 4, 5 and 6
STUDY AREA
LIMITS
EXISTING
DUMP
HWY 89-93
HWY 60-70
HASSAYAMPA
RIVER
AGUILA 25 MILES
FROM WICKENBURG
2200
2400
32
33
34
35
36
2
3
4
5
7
9
15
16

JOHN CAROLLO ENGINEERS
PHOENIX — LAFAYETTE — EL PASO

WICKENBURG STUDY AREA, 1967
MARICOPA COUNTY, ARIZONA

SI-9 Plate No. I-P7

The Wickenburg study area is indicated on Plate I-P7 (Page S 1-9).

TIME: Few past records of recent solid wastes haul and disposal operations exist in Maricopa County. This study includes an audit of past records which were found.

Present characteristics of solid wastes and disposal procedures are listed and analyzed from existing records based on current practices of recording in the various municipalities. But those records are incomplete, and some special studies were undertaken at our request by some cities to supplement current, normal records. Records of other areas than Maricopa County were also used to supplement local records.

This study and Report includes estimates of factors, characteristics, and magnitude of solid wastes production by decades for the years 1970 to 1980, 1980 to 1990, and 1990 to 2000. The recommended solid wastes disposal plan is composed of three sections conforming to that division into decades.

TERMINOLOGY

Confusion in terminology is common in solid wastes data. When clarity is established in solid wastes terminology, and uniformly employed, the improved records can aid analysis. Precise terminology is difficult to assign in this field due to both the heterogeneous character of solid wastes and the variable educational background of personnel in this field.

Standard terms have been proposed in Table 3, "Municipal Refuse Disposal," prepared by the American Public Works Association. The examples indicate concern with urban wastes only.

We propose that meaningful terms be developed and expanded to include solid wastes originating in all of Maricopa County. The revised table is offered as a guide to better understanding of the occurrence and characteristics of solid wastes in Table I-T1 (Page S 1-12).

In the first column of Table I-T1 names are given for kinds of waste. Human activities produce solid wastes accumulating at characteristic locations as indicated in the second column. The three headings under "Composition" are "Vegetable," "Animal," and "Mineral." These refer to the materials in their initial form as waste and imply a general degree of resistance to decomposition. The four headings under "Stability" are "Inert," "Reactive," "Putrescible," and "Hazardous." These refer to the materials' tendency to decompose or alter and the relative threat they present to human well-being. Dominant characteristics of composition and stability are indicated by initial letters, subordinate characteristics by "x."

Changes in human activities will change characteristics and amounts of waste. The listed human activities appear to be basic and enduring, increasing with population increase. As human activities become more variable, numerous, concentrated, or dispersed, the examples and combinations of wastes will become more diverse and, with population increase, waste production will increase.

No means is readily available for public agencies to limit, to a significant degree, the growing volume and diversity of solid wastes. Provisions must be made for safe and economical disposal in the future of materials which cannot be defined at this time. This proposition is not

Table I-T1

SOLID WASTES CLASSIFIED BY COMBUSTIBILITY, COMPOSITION, AND STABILITY

Kind of Waste	Location of Waste Accumulation	Composition			Stability				Typical Examples
		Animal	Vegetable	Mineral	Inert	Reactive	Putrescible	Hazardous	
(1)	(2)	(3)			(4)				(5)
Combustible rubbish	Houses, offices, yards, warehouses, wholesale and retail outlets, manufacturing plants, and, simply, where humans congregate	x	V		I				Newspapers, magazines, books, stationery, cartons, boxes; trees, shrub and grass trimmings; leaves, straw, cotton hulls; wood and fibre furniture, rugs, drapes, curtains, bedding; scraps of wood, cloth, paper, plastic, leather, rubber
Semi-combustible (garbage)*	Farms, processors, markets, restaurants, houses	A	V	x		R	P		Raw or cooked food scraps: culls, excesses, carrot tops, lettuce leaves, potato peelings, meat trimmings, citrus rinds, egg shells (not wrappings, cartons, cans, or bottles)
Non-combustible rubbish	Generally, the same as combustible rubbish	x	x	M	I			x	Metal furniture, appliances, bed springs, tools, mechanical equipment and parts; cans; dirt, brick, glass, ceramic, rock, concrete, wire, ashes, car bodies

---

*Garbage is composed of wet combustible material which usually requires auxiliary fuel to ignite and maintain combustion.

"A," "V," "M," designate major portions as Animal, Vegetable, or Mineral, respectively.

"I," "R," "P," "H," designate major portions as Inert, Reactive, Putrescible, or Hazardous, respectively, and refer to the progressively greater threat to human environment.

Note: The classifications of Garbage, Combustible rubbish, and Noncombustible rubbish are not the fractions normally found at collection points; heterogeneous mixtures of all three are common.

unreasonable when one considers the diverse properties of the listed solid wastes examples. An example of future solid wastes, whose properties would differ significantly from every current example of solid wastes, is difficult to imagine. However, man is creative and has long produced solid wastes in particulate form in the air in which he must live. The current concern with air pollution is one result. Silicosis in miners and explosions in flour mills and coal mines are other examples of the bad effects of solid wastes in particulate form. Covered dumps, landfills, and sanitary landfills all emit gases which can explode and burn. Responsible people will be alert to recognize new forms of solid wastes.

Solid wastes are readily separated (on paper) into classifications and neat fractions of typical examples. It should be understood, however, that solid wastes occur in endless combinations defying actual separations. No practical means of changing this characteristic is evident, and problems resulting from the heterogeneous character of solid wastes are expected to continue.

Table I-T1 (Page S 1-12) and Tables I-T2 through I-T5 (Pages S 1-14 through 1-17) classify the components of solid wastes several ways to accent the characteristics which limit effectiveness of all the disposal practices commonly in use.

Table I-T2

SOLID WASTES
CLASSIFIED BY SOURCE AND COMBUSTIBILITY

	Combustibility		
Source of Waste	G	C	N
Residential	x	C	x
Roadway Litter	x	C	x
Commercial			
Restaurants, Markets, and Food Processors	G	C	x
Others	x	C	x
Industrial			
Manufacturing		C	x
Demolition		x	N
Construction		C	N
Agricultural			
Animal Wastes	G	x	
Vegetable Wastes	G	C	

"G," "C," and "N" designate major portions as Garbage, Combustible, and Noncombustible.

"x" designates minor portions as Garbage, Combustible, and Non-combustible.

Table I-T3

SPECIAL WASTES CLASSIFIED BY COMPOSITION AND STABILITY

(Sometimes disposed with solid wastes)

	Composition			Stability			
	A	V	M	S	U	P	H
Dead Animals							
Pets	A				U	P	x
Livestock	A				U	P	x
Pathological Wastes							
Tissue	A				U	P	H
Cloth, glass, etc		V	M	S	x	x	H
Sewage Residue							
Cesspool Wastes	A	V	x		U	x	H
Sewage Sludge			x				
Abandoned Vehicles							
Autos, trucks, etc			x	S			
Unsalvaged parts			x	S			
Chemical Wastes							
Acids				S	x		H
Caustics				S	x		H
Salts				S	x		H
Insecticides, herbicides				x	U		H
Oil, tar, and asphalt				S	x		H
Radioactive Wastes							
Radioactivated liquids or solids					U		H
Explosives							
Sticks, bags, bulk, caps					U		H
Burning Combustible Wastes							
Smoldering combustible solids	x	V			U		H

"A," "V," "M" designate major portions as Animal, Vegetable, and Mineral, respectively.

"S," "U," "P," "H" designate major portions as Stable, Unstable, Putrescible, Hazardous, respectively.

"x" designates a minor portion as Animal, Vegetable, etc, respectively.

Table I-T4

CLASSIFICATION OF WASTES TO BE INCINERATED

(Source: Incinerator Standards, Incinerator Institute of America)

Classification							
Type	Description	Principal Components	Composition % by Weight	Moisture Content %	Incombustible Solids %	BTU Value/lb of Refuse as Fired	BTU of Aux Fuel/lb of Waste to be included in Combustion Calculations
0	Trash	Highly combustible waste, paper, wood, cardboard cartons, incl. up to 10% treated papers, plastic or rubber scraps; coml. & industrial sources	Trash 100%	10%	5%	8500	0
1	Rubbish	Combustible waste, paper, cartons, rags, wd. scraps, combustible floor sweepings; domestic, coml. & industrial sources	Rubbish 80% Garbage 20%	25%	10%	6500	0
2	Refuse	Rubbish & garbage; residential sources	Rubbish 50% Garbage 50%	50%	7%	4300	0
3	Garbage	Animal & veg. wastes, restaurants, hotels, markets; institutional, coml., & club sources	Garbage 65% Rubbish 35%	70%	5%	2500	1500
4	Animal solids & organic wastes	Carcasses, organs, solid organic wastes; hospital, laboratory, abattoirs, animal pounds, and similar sources	100% Animal and Human Tissue	85%	5%	1000	3000
5	Gaseous, liquid or semi-liquid wastes	Industrial process wastes	Variable	Dependent on predominant components	Variable according to wastes survey	Variable according to wastes survey	Variable according to wastes survey
6	Semi-solid & solid wastes	Combustibles requiring hearth, retort, or grate burning equipment	Variable	Dependent on predominant components	Variable according to wastes survey	Variable according to wastes survey	Variable according to wastes survey

All figures are approximate, based on analysis of many samples.

Table I-T5

ESTIMATED HEAT OF COMBUSTION FROM SELECTED SOLID WASTES

(Source: Incinerator Standards, Incinerator Institute of America)

Waste	BTU Value/lb as Fired	Wt in lbs per cu ft (Loose)	Wt in lbs per cu ft	Content by Weight in Percentage	
				Ash	Moisture
Type 0 Waste	8,500	10		5	10
Type 1 Waste	6,500	10		10	25
Type 2 Waste	4,300	20		7	50
Type 3 Waste	2,500	35		5	70
Type 4 Waste	1,000	55		5	85
Newspaper	7,975	7		1.5	6
Brown paper	7,250	7		1.0	6
Magazines	5,250	35		22.5	5
Corrugated paper	7,040	7		5.0	5
Plastic coated paper	7,340	7		2.6	5
Coated milk cartons	11,330	5		1.0	3.5
Citrus rinds	1,700	40		.75	75
Shoe Leather	7,240	20		21.0	7.5
Butyl sole comp.	10,900	25		30.0	1
Polyethylene	20,000	40-60	60	0	0
Polyurethane (foamed)	13,000	2	2	0	0
Latex	10,000	45	45	0	0
Rubber waste	9,000-11,000	62-125		20-30	
Carbon	14,093		138	0	0
Wax paraffin	18,621		54-57	0	0
1/3 Wax, 2/3 Paper	11,500	7-10		3	1
Tar or asphalt	17,000	60		1	0
1/3 Tar, 2/3 Paper	11,000	10-20		2	1
Wood sawdust (pine)	9,600	10-12		3	10
Wood sawdust	7,800-8,500	10-12		3	10
Wood bark (fir)	9,500	12-20		3	10
Wood bark	8,000-9,000	12-20		3	10
Corn cobs	8,000	10-15		3	5
Rags (silk or wool)	8,400-8,900	10-15		2	5
Rags (linen or cotton)	7,200	10-15		2	5
Animal fats	17,000	50-60			0
Cotton seed hulls	8,600	25-30		2	10
Coffee grounds	10,000	25-30		2	20
Linoleum scrap	11,000	70-100		20-30	1

The above chart shows the various BTU values of materials commonly encountered in incinerator designs. The values given are approximate and may vary based on their exact characteristics or moisture content. One British Thermal Unit (BTU) is defined as the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

SECTION 2

CURRENT SOLID WASTES DISPOSAL METHODS

INDEX

SECTION 2 - CURRENT SOLID WASTES DISPOSAL METHODS

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SECTION 2

CURRENT SOLID WASTES DISPOSAL METHODS

GENERAL

In this section of the Report production of solid wastes will be discussed as the source of disposal problems. Methods of collection, haul, and disposal will be considered as they relate to each other. The status of disposal technology will be reviewed.

PRODUCTION OF SOLID WASTES

The amount of solid wastes to be collected for disposal is the amount produced less the sum of the amount salvaged and the amount disposed on site. But data are not available to define, quantitatively, salvage and/or disposal on site. Therefore the numerical factors are indeterminant for relating present solid wastes production, salvage, collection, and disposal.

USEFUL INDUSTRIAL PRODUCTION VS WASTES PRODUCTION: Some current solid wastes studies are attempting to find reliable factors relating quantities of useful production to quantities of waste production in specific industries. No significant conclusions can be reported now.

EFFECT OF SALVAGE ON SOLID WASTES DISPOSAL: Production of solid wastes continues with varying rates and kinds in relation to human activities. Production of wastes is not planned but is a by-product of activities. In our society, regulation of solid wastes production is limited and achieved, principally, by salvage. One example is the secondary metals industry. In times of national emergencies some federal regulation of metal waste production has been achieved by increasing salvage efforts. Concurrent construction and demolition wastes increased tremendously.

Salvage efforts vary less at individual production sites than at disposal sites in response to the salvage market. A decrease in salvage effort at an industrial plant, for example, adversely affects housekeeping, efficiency, safety, etc. Thus industrial wastes salvage is not free to respond directly to the salvage market. An industrial firm may choose to subsidize salvage operations where the subsidy can cost less than waste disposal. Thus the extent of salvage operations may vary directly to cost of disposal.

Salvage of abandoned automobiles is a striking example of how high disposal costs contribute to development of an impressive salvage industry. In Maricopa County no significant tonnage of abandoned automobiles escapes the salvage industry while most disposal sites do not accept automobiles for disposal.

On-site salvage diverts a significant amount of material from becoming solid waste at that time. Disposal site salvage retrieves a fraction of useful material from the gross amount which left production sites as waste.

Frequently salvage operations are not followed quickly by release of salvaged material into useful production. Storage sites for salvaged material frequently become troublesome because of that delay. Examples of objectionable storage sites for salvaged material include junk yards, compost piles, auto wrecking yards, and manure piles.

EFFECT OF ON-SITE SOLID WASTES DISPOSAL: Agricultural solid wastes are largely disposed on site. Vegetable wastes on forms include straw, stems, hulls, spoiled hay, spoiled melons, fruit culls, etc. Those wastes are often plowed into the soil. Useless machinery and tools are commonly traded in on purchase of new items or sold as scrap metal. Garbage and other household wastes may be burned or buried. Manure is frequently accumulated and spread on fields seasonally. Stockyard and/or dairy manure is commonly a problem where storage sites are near urban centers.

Amounts of commercial and industrial wastes to be collected for disposal are diminished by incineration on site of combustible wastes, principally paper, cardboard, and wood. In Section 4 of this Report 175 on-site incinerators in Maricopa County are recorded. Their primary purpose is evident from the classes of major users:

14	Cemeteries and mortuaries	Cremation
4	Retirement and nursing homes	Disinfection
12	Medical centers, hospitals, and sanitariums	Disinfection
48	Educational institutions	Reduce volume
40	Financial institutions	Security
32	Retail businesses	Reduce volume
6	Industries	Prepare for salvage or reduce volume

Salvage and disposal on site are certainly significant factors relating production rates for wastes to collection rates for wastes. It is evident that those factors will vary significantly, and there is no data on current rates that can be quantitatively related for material purchase, production, salvage, disposal on site, and wastes collections.

CHARACTERISTICS OF SOLID WASTES

Table I-T1 (Page S 1-12) classifies numerous typical examples of solid wastes in Maricopa County. Table I-T2 (Page S 1-14) lists sources of wastes, i.e., places where wastes accumulate and require collection.

RESIDENTIAL WASTES are either contained in garbage cans, boxes, tied bundles, or loose as yard wastes, furniture, etc. It is common practice for sanitation crews to load these items from alleys or curbside into compactor collection trucks, open trucks, or trailers.

Most cities and towns provide this collection service within their boundaries. Private firms also provide this service, sometimes for entire cities by contract but, more commonly, in unincorporated places and small towns. Private and public sanitation crews use similar equipment and variously trained crews. There is no significant difference in the operation at the disposal site due to agencies of residential collection.

Individuals also haul residential wastes to the disposal site. Special provisions must be made for them to maintain efficiency and safety at the disposal site. The mechanical limitations of their vehicles and limitations of their training cause recurring problems.

ROADWAY LITTER is probably the most completely understood solid waste in the United States as a result of the anti-litter advertising campaign. From children to senior citizens litter bags symbolize a cooperative effort to keep our streets and highways clean. Anti-litter laws threaten the litterbug. Each effort helps some, but in the end special crews and equipment are required to keep our roadways presentable and sanitary.

No special problem arises from the delivery of roadway litter to the disposal site. The load usually consists of dirt, paper, leaves, and plastics gathered by a mechanical street sweeper; accumulations of the same things from catch basins; cans, bottles, boxes, and garbage thrown out of cars; and items which have fallen off improperly loaded trucks.

COMMERCIAL SOLID WASTES comprise a large proportion of the total. Garbage from restaurants, markets, and food processors is usually collected by private collection firms. These business places alternate with other businesses in higher density zones resulting in concentrations of rubbish and garbage.

Salvage of paper, meat scraps, and cardboard requires special collection of these items in commercial zones. A small proportion of commercial solid wastes is collected for salvage.

Disposal in Maricopa County is limited to disposal on land and burning. Rubbish from commercial areas usually creates no special disposal problem. Exceptional items creating disposal problems include large metal cans to be crushed or salvaged and rubber tires which move under cycles of compression and release.

INDUSTRIAL SOLID WASTES are of a literally endless variety. Demolition wastes are predictable in the sense that demolition normally follows close association of people with structures for years before those structures are demolished. Demolition requires disposal of old building materials, equipment, furnishings, and other rubbish from the sites. Salvage is frequently an economic consideration in demolition work.

Disposal operations can usually receive, place, and cover manufacturing solid wastes without special problems in Maricopa County.

AGRICULTURAL WASTES are under special study in typical agricultural areas of this country. Studies in Southern California are expected to develop data which may be related to Maricopa County in the future. Locations of current problems with agricultural solid wastes, for example, burning, are at the boundaries between intensely developed agricultural and urban areas.

Maricopa County field crop wastes produce some seasonal problems. Examples include rotting melons and lettuce. A continuing problem occurs at cattle feeding pens where manure and urine decompose and contribute to the production of insects and odors.

Extensive use of vegetable wastes as stock feed and soil conditioner represents a large salvage operation within the agricultural industry. Pesticides contaminate and can reduce vegetable wastes from stock feed or green compost to a dangerous waste. Production of manure at dairies, cattle feeding pens, and poultry farms usually exceeds the seasonal demand for manure as a soil conditioner-fertilizer. The excess is, however, not a problem at disposal sites of the municipalities because the manure is usually not collected. Public acceptance of temporary odors from steer manure is demonstrated when they pay to have it spread on their lawns. However, public complaints are common against continuing steer manure odors near feeding pens and stockyards.

Collection of manure and rotting vegetable matter would impose an increased capacity load on disposal operations but can be done by sanitary landfill.

COLLECTION OF SOLID WASTES

It is common practice to record amounts of solid wastes collected. However, the units of measure are more commonly truck counts than weights. Truck counts may be a basis for estimating volume of wastes collected, and this kind of record is quite commonly computed.

Waste weights, truck counts, and waste volumes are sometimes recorded for each kind of waste arriving at a disposal site. With those records densities of each kind of wastes on each kind of truck can be computed.

Good, continuing records are a sound basis for day to day management and planning for future operations. In Section 6 of this Report the required County-wide disposal effort is projected to the year 2000. In that year it is estimated that a one percent increase in efficiency in disposal operations will represent a savings of $100, 000 per year.

Present technology is inadequate to provide necessary tools and systems to measure physical features of disposal of solid wastes.

RELATION OF COLLECTION PRACTICES TO SANITARY LANDFILL DISPOSAL PRACTICES

Equipment used in the collection of solid wastes includes standard items and a wide variety of specialized equipment.

Standard equipment includes passenger cars, station wagons, pickups, dump trucks, flat bed trucks, stake bed trucks, two and four-wheel trailers, enclosed furniture vans, and tank trucks. That kind of equipment is normally used for part-time hauling by individuals and businesses hauling for themselves. At the landfill a problem arises of providing safe working space for those vehicles. The drivers are often inexperienced, and the "crew" frequently includes women and children.

At the 19th Avenue Phoenix landfill the maximum day tonnage by "free vehicles," principally the types mentioned above, was 192 tons. The variety of wastes hauled by standard equipment to a landfill can create some special problems, not necessarily predictable and occurring sporadically but manageable. The significant problem at the disposal site is one of maintaining adequate working space for heavy equipment while providing safe working conditions and confining the manual dumping area adequately.

Equipment used by full-time collectors is predominantly specialized equipment hauling most of the solid wastes tonnage. Disposal sites are specifically planned to receive solid wastes from specialized equipment. Compacted loads and uncompacted loads are received. Unloading methods are determinants in landfill planning.

Both private and municipal full-time collection forces use collection trucks and trailers both with and without compaction elements. Private and municipal collection truck crews are trained; both are generally competent in approaching, unloading, and leaving the designated unloading site.

There are four types of specialized truck equipment delivering to landfills:

1. Closed packer trucks for direct haul
2. Open trucks and trailers for direct haul
3. Container collector for direct haul
4. Container collector for compaction and haul

Closed collectors which compact the solid wastes within their bodies and unload at the disposal site include special alternate features:

A. Manually loaded from sides or rear
B. Cylindrical to rectilinear in shape
C. A variety of packer systems and unloading devices
D. Capacity ranges of about 10 to 60 cubic yards
E. Owner's choice of truck chassis, engine, etc.

At the disposal site various closed collectors unloading compacted solid wastes provide a common task to the disposal crew varying, principally, in size of load. These loads commonly include garbage.

Open collection trucks hauling directly to the disposal site provide no significant compaction of bulky solid wastes. Nonputrescible wastes from yard work provide a typical, bulky load of brush, leaves, boxes, furniture, etc to be unloaded and disposed.

Container collector trucks include two types. One type empties special large containers into its body where solid wastes are compacted for haul to disposal site. Another type loads large containers onto its chassis for haul. These average larger in size than closed collector-compactor trucks and are commonly designed for one-man operation, longer haul, and longer trip time. Some models are self-unloading by means of ejector rams or tilt-up frames. Other models require aid from disposal equipment in unloading. The "train" system of collection uses two-wheel trailers in tandem pulled by a Jeep, a Scout, or a pickup. The trailer bodies are special containers. A front loading tender truck tips trailers over the cab into a top opening in a compactor body. The system therefore consists of manual collection into trailers, transfer by dumping into the tender, and one-man haul in the tender to the disposal site. The same tender loads from special containers in commercial areas as part of the system.

In addition to specialized vehicles for collection, compaction, and haul there are specialized machines used to decrease the gross volume of bulky solid wastes. Brush chippers are hand fed at the collection point. They chip brush and small limbs into a greatly reduced volume for more economic haul in open trucks to disposal. Power saws are used to cut larger limbs and tree trunks into pieces which can be hand loaded. Truck cranes are used to load objects too large for manual loading. Haul and disposal are simplified where special equipment is used to reduce the size of objects to be loaded. Disposal is complicated and requires more time and effort when oversize objects are loaded by special equipment.

Some landfills are operated to receive all solid wastes and some liquid wastes. A greater variety of wastes is then collected and special problems are imposed upon the disposal system.

Frequency of collections affects the volume of solid wastes collected by the same agency. Many studies have shown that the amount of residential wastes collected by an agency in two collections per week exceeds the amount collected by that agency in one collection per week. Those records are commonly based on volumetric records, not weight records.

But, where on-site disposal and salvage is not practiced, total collection must be practiced in the long run. Noncombustibles must be collected by some combination of agencies. One effect of infrequent collections is to force individual residents to haul their own wastes. A related effect is an increase in promiscuous dumping along isolated roadways even where laws forbid that practice. Increased density of collectible wastes may be expected with less frequent collections.

Tucson collects residential solid wastes twice per week on a four-day schedule. On Wednesdays they concentrate on trash collections. The most pronounced effect on the landfill operation is to change the character of material to be compacted in the fill on Wednesdays.

Daily collections of brush in separate trucks and trailers, as in Phoenix, create a daily peak hour load at the landfill. The last hour in the brush collector's working day is the time that all brush trucks and trailers arrive at the landfills. Three effects on landfill operations are:

1. Need for more working room at the toe of the working face,

2. Need for more open face of solid wastes to accommodate the late surge of brush, and

3. Need to reserve some contained wastes to work into the voids in brush, thus reducing the amount of soil cover to be placed.

Peak hour delivery by garbage trucks and individual businesses may coincide with peak hour brush delivery. The effect then is to magnify the three problems mentioned above and establish the capacity of equipment required where the face is to be covered after the disposal crews' working day. Phoenix minimized the problems created by the last hour delivery by breaking down and spreading the last solid wastes collected, sprinkling the working face with water over night, and compacting it during the first hour or two of the next working day. This practice was abandoned in favor of daily earth cover as reported on December 11, 1967.

It is evident that residential, commercial, and industrial solid wastes accumulate at collection points gradually throughout each day, including weekends. Solid wastes quantities delivered daily at disposal sites result from collection practices. Peak day and peak hour rates of delivery are created by collection practices and not by production practices.

Quality of solid wastes at the disposal site is designated by the relative proportions of kinds of wastes received. Collection practices are factors in composing the average quality of solid wastes arriving daily at the disposal site. Disposal methods must be devised to accommodate variations in both quantity and quality of solid wastes. Some control of daily variations may be achieved by adjusting collection schedules.

PROBLEMS INHERENT IN SOLID WASTES DISPOSAL

Disposal of solid wastes has been accomplished in water, in air, and on land. Contamination of water and air has resulted from solid wastes disposal. Federal, state, and county governments are now establishing regulations to limit pollution of air and water. Future regulations are expected to be more restrictive than present regulations.

WATER POLLUTION: Each use and reuse of water adds some amounts and kinds of contamination. Thus contamination is commonly accumulative from varied sources and successive uses.

Solid wastes include a variety of water soluble compounds ranging from harmless to poisonous. Water trapped in or flowing from a mass of solid wastes may support colonies of living organisms ranging from microscopic to visual size.

Prevention of water pollution is one phase of the program to maintain useful water. Disposal of solid wastes in swamps, tidelands, oceans, bays, and lakes is hazardous. Less obvious, but also hazardous, is the practice of placing solid wastes below groundwater level. Intermittent saturation of solid wastes followed by drainage into a water supply will very likely pollute the supply.

It is evident that disposal of solid wastes in water in Maricopa County should not be considered. One consideration in design of sanitary landfills is the possibility of water pollution.

AIR POLLUTION: The aim of air pollution regulations is to limit the total accumulation of pollutants to a safe maximum proportion of the atmosphere. Regulation of each source of pollutant is the intention. Where unnecessary activities result in air pollution, those activities will be outlawed. Where necessary activities result in air pollution, those activities will be regulated to effect minimal pollution.

Solid wastes disposal in water and on land does produce air pollutants at times. Dumps burning intentionally or unintentionally spread smoke and fly ash over the surrounding area.

Incinerators used to burn combustible solid wastes are commonly inefficient, producing obnoxious gases, fly ash, and smoke. The technology of larger incinerators suitable for municipal use has not yet assured an economically feasible system for controlling air pollution within the standards for Arizona.

It is evident that air pollution is an ever present threat where burning of solid wastes is practiced.

UNSANITARY DISPOSAL OF SOLID WASTES

It should be recognized that technology alone does not guarantee sanitary disposal of solid wastes. The basic technology of the sanitary landfill method for disposal of garbage was established and was in use by the military services in 1940. Many cities and counties have adopted that method even in preference to existing incineration plants. Yet unsanitary open dumps and burning dumps are common in 1967 throughout the United States. In early 1967 only Tempe and Glendale were operating sanitary landfills in Maricopa County.

DISPOSAL TECHNOLOGY

DISPOSAL OF SOLID WASTES BY SANITARY LANDFILLS:

Landfills are places on land filled with solid wastes and covered with earth. To be sanitary a landfill must proceed in accordance with an engineering plan which precludes the creation of health hazards. Sanitary landfilling is the only method available on land as a sanitary disposal method for all solid wastes. In addition it provides a place for sanitary disposal of waste fluids such as oils, distillation residues, acids, caustics, and cesspool pumpage. Disposal of these special wastes is commonly not provided for at wastewater treatment plants.

The prime object of sanitary landfilling is to bury solid wastes. Volume reduction is attained by compaction in place. Sanitation is attained by compaction and earth cover in cells which minimize drainage, fire, access to pests, and gas release to acceptable sanitary standards.

Pretreatment of solid wastes at landfills is unnecessary. Salvage operations actually interfere with the pace and sequence of heavy equipment operations. Grinding or shredding of residential solid wastes is being investigated at Madison, Wisconsin. Preliminary data indicates the costs would be out of proportion to benefits where the shredded wastes were to be disposed in a sanitary landfill. Brush and tree limbs are reduced to chips to reduce the volume of haul in some cities. Stationary chippers at sanitary landfills hold little promise where brush can be combined with other, less bulky solid wastes. Incineration of brush and logs exclusively in Detroit, Michigan has proven feasible where Dutch Elm disease required a massive tree removal program. The resulting volume of ashes sent to landfill was negligible. Open burning of wastes at the disposal site creates unsanitary conditions.

Segregation of individual truckloads may be beneficial and even necessary at a sanitary landfill. Solutions and slurries may require some special placement. For security reasons some products and papers are given special placement. Animal bodies, especially of pets, should be promptly covered to maintain public acceptance of the method.

Equipment properly used at a sanitary landfill is adapted to both bulky and dense material. One limit of the applicability of the sanitary landfill method is imposed by the large size and corresponding cost of equipment needed. Both small and large communities discard individual large items such as furniture, appliances, metal drums, etc. Special, large equipment is needed to efficiently compact large items in place. A small community which produces a small tonnage of solid wastes may not be able to afford large disposal equipment.

Where several nearby communities can share the costs of sanitary landfill, large, effective equipment may provide low unit disposal cost to each community which could not otherwise afford that method of disposal.

Each sanitary landfill requires an engineering plan as a basis for controlled, successive operations. Regulation of sanitary landfills in Maricopa County is the subject of Regulation 4, Section 4, Chapter II of the Maricopa County Health Code. The basic, minimum requirements of engineering design are listed there. The proposed design is subject to approval by the Maricopa County Health Department.

Regulations of the State Department of Health are also applicable to design of sanitary landfills in Maricopa County. The Division of Environmental Health, Arizona State Department of Health, has published Engineering Bulletin Number 14, "Basic Criteria for Solid Waste Disposal by Sanitary Landfill." It is an information bulletin and not a regulation.

Design of a sanitary landfill is an engineering problem which includes haul factors as well as disposal factors. General studies of site selection are included in Section 6 of this Report.

Sanitary landfills are commonly predicated on the original land topography. Flat land, not necessarily level, may be trenched to provide space below original ground level. Succeeding trenches are generally parallel with undisturbed or compacted earth left between rows of waste. Daily earth cover divides each row into cells of waste isolated by earth cover.

Low, level areas and uneven terrain may be benefited by application of the area method of fill. The area method consists of little or no excavation, fill beginning at an accessible place along the upper level. Cells are shaped to conform to daily volume of waste and a minimum working face. Earth cover may be imported if the water table or soil type prevents borrow.

The progressive slope method usually starts against a sloping bank of earth. Excavation precedes placement of wastes, and the excavated earth is placed over the face of waste and on top of the day's cell.

Trench, area, and progressive slope methods may all be modified and combined to accomplish the most economic use of a site.

Technology of landfill design and operation has progressed enough to make possible the analysis of some factors. Compaction, leaching, gas release, and after-settlement need study.

The optimum theoretical location for a sanitary landfill is at the point which represents minimum average haul cost from collection points. Minimum disposal cost will not likely be attained there in practice. Minimum total cost is attained at the optimum practical location. The centroid of waste producing population approximates the optimum theoretical location with reference to residential solid wastes. Where commercial and industrial wastes are accepted, the effective centroid of collection should recognize the relative amounts and locations of commercial and industrial waste production. The analysis is one analagous to basic physics problems.

Travel time as well as distance is a factor in haul cost. A sanitary landfill is a traffic generator, being a truck terminal. Traffic engineering is a discipline available to help in site selection.

Design of access roads, scale house, entrance pattern, fencing, water supply, equipment yard, maintenance facilities, power, and lighting are all problems which can be solved by known engineering methods.

Landscaping of sanitary landfill perimeters should be a part of the final usage plan. Examples of successful developments on completed landfills include parks, playgrounds, golf courses, athletic fields, parking lots, and agriculture. After-settlement and gas release are unavoidable at completed landfills.

Compaction of solid wastes is far more an art than a science.

Engineering analysis of full scale operations will be required to accumulate reliable data on compaction factors. Some random studies have been made and some are now in progress. However, very few landfills are equipped with the first tool, a truck scale. Sources and kinds of wastes are seldom identified and recorded by weight. Volumes of earth cover are seldom measured. Compactive effort was not considered in any reports reviewed in this study. Gross areas and gross volumes are commonly considered without adjustment for roads, drainageways, fill slopes, etc. Optimum moisture and effects of moisture content in solid wastes have not been determined.

At the Phoenix 16th Street landfill City trucks dumped residential, street, and parks wastes at the working face toe where they were spread up a 15-foot lift and compacted by track dozer. Average net density was calculated to be 1,010 pounds per cubic yard by measured net waste volume and weight.

Cost records from Maricopa County communities include a range of $0.13 to $0.38 per cubic yard as delivered and estimated on trucks. These rates cannot be converted to dollars per ton because average densities are not known. Disposal cost in Tempe was $0.95 per estimated ton in a favorable pit site. Average disposal cost for three sites in Phoenix was $1.65 per ton in less favorable sites. Reported sanitary landfill costs in this nation range from $0.50 to $2.50 per ton.

The following tabulation is intended for comparison with estimated unit disposal costs by salvage (composting) and incineration in Maricopa County, 1968. The site is eroded valley soil requiring about 50 percent excavation, worse than the Tempe site and better than the Phoenix site at 16th Street.

300-TON PER DAY SANITARY LANDFILL
ESTIMATED FIRST COSTS PLUS OPERATING COSTS
(Based on 40-Acre Site)

FIRST COST	Amt	Unit	Unit Rate	First Cost	Life Exp	Annual First Cost	Unit Cost	
			$	$	(Yrs)	$	$/Ton	%
Land	40	Acres	3,000	120,000	10	12,000	0.11	7.2
Improvements							0.05	3.3
Scale House	1	Each	15,000	15,000	10	1,500		
Roads	1	LS	16,000	16,000	10	1,600		
Other	1	LS	24,000	24,000	10	2,400		
Equipment							0.40	26.3
Track Dozer	2	Each	60,000	120,000	5	24,000		
Earthmover	1	Each	60,000	60,000	5	12,000		
Grader	1	Each	30,000	30,000	5	6,000		
Other	1	Each	10,000	10,000	5	2,000		
Total First Cost				$335,000				
Annual First Cost						$61,500		
Unit First Cost (110,000 Tons)							$0.56	36.8

OPERATING COST	Amount	Unit	Unit Rate	Annual Cost	$/Ton	%
			$	$		
2 Dozers	5,000	Hrs	7.00	35,000		
Earthmover	2,500	Hrs	7.00	17,500		
Grader	1,000	Hrs	7.00	7,000		
Other	1,000	Hrs	6.00	6,000		
Subtotal Operating Cost				$65,500		
Other Labor	2	Yrs	7,000	14,000		
	1	Yr	10,000	10,000		
Annual Operating Cost				$89,500		
Unit Operating Cost (110,000 Tons)					0.81	53.2
Total Unit Sanitary Landfill Field Cost					$1.37	90.0
Supporting Office Cost @ 11% of Field Cost					0.15	10.0
Total Unit Sanitary Landfill Cost					$1.52	100.0

DISPOSAL OF SOLID WASTES BY INCINERATION:

General. Incineration means to burn or "be consumed by fire." It is important to understand what changes are made in solid wastes by subjecting them to incineration. "Consumed by fire" seems to imply that matter has been destroyed, is gone, and is no longer a problem. But that is not true of solid wastes "consumed by fire."

Burning of solid wastes results in one principle chemical change and three principle physical changes. The chemical change is oxidation of organic matter. The physical changes include change of state of:

1. Organic solids to gases
2. Liquid water to water vapor
3. Reduction in solids volume

When incinerators are designed and operated to attain complete combustion of organic solids, gases produced are substantially carbon dioxide and water vapor. These are oxides of carbon and hydrogen. These gases along with a small percentage of oxides of nitrogen are exhausted into the atmosphere along with nitrogen from air which supplied oxygen for combustion. Moisture from solid wastes is evaporated and dispersed in exhaust gases.

Noncombustible wastes are merely heated during incineration and then cooled to permit handling. They include ash, the finer particles, and concrete, brick, ceramics, most metals, dirt, etc.

Special Incinerators for Special Wastes. Complete combustion of organic wastes results in nearly complete disposal in air. Examples of nearly pure, organic wastes are logs, branches, and leaves. In Detroit, Michigan a specially designed incinerator for these wastes produced ash amounting to about one-tenth of one percent by weight of the waste fed to the incinerator.

On-site incinerators at financial institutions burn paper almost exclusively. Ash residue volume is of no significance.

These high efficiencies do not result primarily from good incinerator design or operating technique, although those factors are important. Uniform quality of wastes is the primary factor in attaining these high efficiencies. Collection practices provided for, and incinerators were designed for, those particular wastes.

Crematoriums are provided for cremating either human bodies or bodies of dogs, cats, and other pets. Crematoriums are efficient incinerators designed to incinerate special wastes. When misapplied, as in feeding excess pen litter to pet crematoriums or simply in feeding pet bodies at an excessive rate, the crematoriums are not efficient and fail to attain complete combustion. They are relatively expensive to operate as they require auxiliary fuel to maintain adequate temperature.

Municipal Incinerators. Quality of feed to municipal incinerators depends largely upon collection and haul practices. Residential wastes include variety in quality requiring compromises in design to compensate for variations from the "average quality." Average quality is, at best, a rough estimate. Where commercial wastes collections are combined in trucks with residential wastes collections, greater variations are to be expected. Where separate commercial and residential wastes collections are combined at the incinerator storage bin, still greater charging variations are predictable.

Referring to Table I-T4 (Page S 1-16) mixed wastes commonly incinerated are classified in Types 0 through 6. The footnote reads: "All figures are approximate, based on analysis of many samples." Tabulated net heat values are expressed in Btu per pound of refuse as fired. Type 4 is 1,000 and Type 0 is 8,500; the difference indicates a heat value range of 7,500 Btu per pound.

Referring to Table I-T5 (Page S 1-17) heat values for specific materials expected to be received at municipal incinerators vary from 1,000 to 20,000 Btu per pound. Explosives are not included because they would not knowingly be fed to an incinerator. Those figures tend to indicate the wide range of thermal loads imposed upon a municipal incinerator.

Optimum operating temperature in a municipal incinerator minimizes physical damage to the plant while completely incinerating combustible wastes. Input heat values can produce a temperature range from so low as to require auxiliary fuel to so high as to require extensive cooling systems to protect the incinerator. Under these expected variations in thermal loading, optimum operating temperature cannot be maintained and efficiency drops.

Physical variations are also common to solid wastes expected at a municipal incinerator. Sizes of individual items received have varied from sawdust to an elephant body. Densities have varied from plastic pill bottles to logs. Shapes include rubber balls, truck tires, mattress cartons, and telephone poles. These are all combustible. Sizes, shapes, and densities of noncombustibles add to the range of mechanical problems imposed by the physical characteristics of solid wastes.

Technology of municipal incineration limits its application to one of three practical applications:

1. Complete combustion of separately collected, predominantly organic wastes.

Advantage of this application is a relatively uniform feed to the incinerator. Uniform feed permits more efficient handling, better temperature control, better air pollution control, maximum volume reduction, and minimum residual solids.

Disadvantage of this application is limited quality of acceptable wastes. On-site incinerators normally operate on this basis. Municipal incinerators of this type require separate, selective collection programs and result in higher collection and haul costs for the total program.

2. Complete combustion of organic wastes in a mixed feed.

Advantage of this application is more efficient, combined collection of more kinds of wastes. This may result in lower collection and haul costs as compared to more selective collection.

Disadvantages of this application are related to variations in feed imposed upon the incinerator and result in mechanical, thermal, and chemical problems. Costs are higher in this application for construction, operation, and maintenance.

3. Incomplete combustion of organic wastes in a mixed feed.

Advantage of this application is reduction of gross volume at high rate of feed to the incinerator.

Disadvantages of this application are prohibitive and include loss of air pollution control Gross volume reduction is limited, and solid residue must be buried in a sanitary landfill. Haul cost from the incinerator to the sanitary landfill is higher than for applications 1. and 2. above.

Owning and Operating Costs for Municipal Incinerators.

Published incinerator cost data reviewed in this study indicate owning and operating costs for municipal incineration vary widely. Reported construction cost based on daily capacity varies from $2,000 per ton to $10,000 per ton. Reported operating cost varies from $2.00 per ton to $6.00 per ton.

Evaluation of those reports on a uniform basis is not possible because they include data on old and new plants, plants applied to different kinds of wastes, plants operated for different purposes, plants operated with and without preliminary sorting for salvage, and plants provided with various means of air pollution control

Table M-T1 (Page S 2-26) is a tabulation of cost estimates for incineration as they would apply to the metropolitan area of Maricopa County. Feed to three alternate plants would be limited to contained residential and commercial wastes. Complete combustion of organic wastes would be intended. An estimate of major maintenance costs is not included. Modern air pollution control elements are included in first costs. However, it is not known that modern equipment will control air pollution within the new regulations for Maricopa County.

Table M-T1

ESTIMATE OF FIRST COST AND OPERATING COST

FOR MUNICIPAL INCINERATION PLANTS

Based on 1967 Prices

Developed in consultation with
Greeley and Hansen Engineers

PLANT CAPACITY IN TONS PER DAY			200		500		1,000	
Item (1)	Unit (2)	Unit Cost (3)	No. Units (4)	Item Cost (5)	No. Units (6)	Item Cost (7)	No. Units (8)	Item Cost (9)
FIRST COST		$		$		$		$
1. Land	Acres	6,000	2	12,000	3	18,000	5	30,000
2. Construction								
a. Building & Grounds		LS		600,000		1,400,000		2,700,000
b. Furnaces & Appurtenances		LS		360,000		900,000		1,800,000
c. Chimneys		LS		100,000		130,000		260,000
d. Cranes		LS		120,000		235,000		350,000
e. Electrical Precipitators	Ton-Day	1,500		300,000		750,000		1,500,000
f. Construction Total				1,480,000		3,415,000		6,610,000
3. Engineering Design	8% line 2f			118,000		273,000		529,000
4. Inspection & Administration	5% line 2f			74,000		171,000		331,000
5. Financing & Interest during Construction	2% line 2f			30,000		68,000		132,000
6. Total First Cost				1,714,000		3,945,000		7,632,000
7. Unit First Cost	$/Ton of Daily Capacity			8,570		7,890		7,632
OPERATING COSTS (Daily)								
1. Labor*	Man-Days							
a. Scales		20	1	20	1	20	2	40
b. Tipping Floor		20	-	-	1	20	2	40
c. Cranes		24	3	72	4	96	7	168
d. Charging Floor		20	3	60	3	60	6	120
e. Furnace Floor		20	6	120	6	120	12	240
f. Ash Floor		20	3	60	3	60	6	120
g. Ash Disposal		20	-	-	3	60	6	120
h. Maintenance Mechanic		26	-	-	2	52	6	156
i. General Labor		20	1	20	4	80	8	160
j. Foreman		32	1	32	3	96	3	96
k. Superintendent		37	-	-	1	37	1	37
Subtotal			18	384	31	701	59	1,297
l. Insurance & Withholding				46		84		156
m. Labor Total				430		785		1,453
2. Utilities & Supplies	Ton-Day	0.60		120		300		600
3. Total Operating Costs				550		1,085		2,053
4. Unit Operating Costs	$/Ton of Daily Capacity			2.75		2.17		2.05
5. First Cost Depreciated in 15 Yrs plus 4-1/2% Interest, $/Ton				2.10		2.03		1.96
6. First Cost plus Operating Cost, $/Ton of Daily Capacity				4.85		4.20		4.01

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*10% of wages added for shift and vacation allowance

An 800-ton per day incinerator for Houston, Texas, was completed in late 1967, cost $4,200,000, and has a predicted operating and maintenance cost of $5.70 per ton. Construction cost was $5,250 per capacity-ton. Depreciated over 15 years, construction cost averages about $1.00 per ton at full capacity. Construction plus operating and maintenance costs are estimated to be $6.70 per ton received, or more, depending upon the actual operating tonnage rate.

An incinerator of 500 tons per day capacity was contracted in 1963 to serve in the Detroit regional program. First cost, including land, was about $3,000,000, or $6,000 per capacity-ton. The initial average rate to be charged for use of the incinerator was scheduled to be $6.75 per ton.

Salvage Operations at Municipal Incineration Plants.

Municipal incinerators usually receive mixed wastes including noncombustibles which are cooled and sorted for salvage. Ferrous metals are commonly removed by magnets and include thin metals. Ash, clinkers, and dirt are used as road building materials in some regions.

European practice sometimes includes waste heat reclamation. American engineers (including Canadians) in 1967 concluded that heat recovery from solid wastes incinerators was practical where a wet-wall incinerator was in use and a hot water or low pressure steam heating demand existed nearby. Generation of electric power was estimated to cost at least $0.03 per KWH under optimum conditions from waste incinerators.

In Maricopa County no municipal incinerator exists, and winter heating demand is not a real consideration. Our electric power supply is adequate, no shortage is foreseen, and the manufacturing cost is less than $0.01 per KWH.

PURPOSE OF COMPOSTING SOLID WASTES

Some kinds of solid wastes are composted in Europe and Asia to meet an existing demand for compost in agriculture. This study has not located a significant, existing demand for compost anywhere in the United States. Most commercial composting plants in the United States have failed financially for lack of an adequate compost market.

Poor compost quality has contributed to the market problem. Two contributing factors in failure to produce a good quality compost have been inadequate mechanical design and inadequate technical supervision.

At the present stage of composting technology, composting is not a disposal method except in the rare case where an adequate compost market has been developed. In that case indirect salvage reduces the amount of disposable wastes. Direct salvage normally precedes composting and attains its total effect on disposal independently of composting.

SPECIFIC COMPOSTING OPERATIONS

RESEARCH PROJECTS: The University of California, Michigan State University, and the United States Public Health Service conducted research projects on composting of solid wastes in the 1950's. The United States Public Health Service and the Tennessee Valley Authority conducted joint research in 1965 on potential market value of compost.

These projects confirmed that some components of selected solid wastes may be converted to compost and the compost could be of value as soil conditioners. However, of nine compost plants reported as beginning operation between 1951 and 1963 six have been closed and three were operating in 1965. Capacities of the three operating plants were 20, 45, and 50 tons per day. In relation to solid wastes disposal programs these plants are classified as pilot plants.

PHOENIX, ARIZONA, COMPOSTING PLANT: One of the six closed plants included in the discussion above was the 300-ton per day Arizona Biochemical Company Plant. This plant used the Dano process of composting in rotating, steel, horizontal drums. This plant operated intermittently and failed financially. In early 1967 equipment was removed from the site. During its active life this operation failed to produce compost of adequate quality to compete with established soil conditioners which include green crops, agricultural wastes, steer manure, dairy manure, peat moss, and vermiculite.

This study included tests of compost stockpiles at the Phoenix plant site. Samples of compost were screened and analyzed with the following results:

SCREEN ANALYSIS

Passing Screen No.	Percent of sample by weight Sample A	 Sample B
4	79.4	98.2
6	71.8	94.7
12	50.3	72.5
20	32.1	52.8
40	17.8	32.6
70	10.5	20.7
100	7.8	16.0
140	5.6	12.4
200	3.6	8.4
270	2.4	1.7

CHEMICAL ANALYSIS

Chemical		Percent of sample by weight Sample A	 Sample B
Phosphorous	(as P_2O_5)	0.57	0.51
Nitrogen	(as N)	2.62	2.12
Crude Fiber		34.0	34.2
Potassium	(as K)	0.59	0.62
Inert		62	63

As a soil conditioner crude fiber, one-third by weight, establishes the worth of this product. The remaining two-thirds by weight is worthless. Compost is not intended to be a rich fertilizer and this material is not. Inert material includes dirt, plastics, glass, china, brick, etc. This "compost" is still solid waste and requires disposal.

In review of this plant's failure the operator concluded that certain necessary items were missing and would be necessary to insure success:

1. Sewage sludge from the sewage treatment plant.

2. A sanitary landfill close by to reduce waste haul cost.

3. A payment from the City higher than their normal disposal cost by landfill ($1.25 per ton).

4. A firm market for the compost.

The major effects on the City's solid wastes disposal program was to:

a. Underestimate the tonnage of solid wastes for which to provide other disposal facilities.

b. Reduce efficiency of day to day landfill operations as the plant did or did not accept part of the day's collection. Both quantity and quality of wastes varies at the landfill in response to selective delivery to the plant.

c. Create an open dump at the plant site.

Another important effect in the community was financial failure of a plant in which local citizens and firms had invested heavily.

HOUSTON, TEXAS, COMPOSTING PLANT: At Houston, Texas, scheduled collections of selected solid wastes were designated for treatment by composting or incineration. Four quadrants of the City were designated as areas to be served by four separate facilities. Technically and/or financially two efforts to establish composting plants failed. An incinerator was officially opened on November 15, 1967. A composting plant became operational on January 10, 1967.

Design of this composting plant is based upon studies conducted at a 50-ton per day proto-type facility operating in Largo, Florida. Lone Star Organics, Inc. operates this 300-ton per day plant in Houston.

First cost, exclusive of land, was $1,700,000 or $5,600 per ton of daily capacity. Houston pays the operator $3.78 per ton, on a 20-year contract, to accept selected solid wastes from City collection trucks. The plant appears to be located advantageously and may reduce City haul costs as compared to alternate disposal sites.

From the 300 tons of residential contained wastes received daily, the plant now accomplishes seven separations in the proportions listed below:

Separations	Tons	Percent
Shredded "tin" cans	27.0	9.0
Rags	1.5	0.5
Aluminum scrap	0.5	0.2
Mixed tramp metals	1.0	0.3
Paper	39.0	13.0
To composting	225.0	75.0
Waste to landfill	6.0	2.0
Total	300.0	100.0

About 65 percent or 195 tons of the 300 tons received daily is paper. Thirty-nine tons of paper are salvaged directly, leaving 156 tons of paper for composting. About 70 percent of the 225 tons to composting is paper.

About 20 tons of the 225 tons composted is glass. Mechanical facilities for salvaging glass fragments from compost were being added to the plant.

Composting time at this plant is 6 days in concrete aeration troughs followed by 90 days in outside storage. Compost quality adequate to succeed on the market has not been attained in spite of selected wastes, modern plant, and competent supervision. Compost is offered for sale at $12.00 per ton.

As this plant relates to its assigned quadrant of the City, it is estimated to accept about 40 percent of residential and commercial solid wastes. Without a market for compost its salvage is about 23 percent of its feed. About 77 percent of its feed is now waste.

GAINESVILLE, FLORIDA, COMPOSTING PLANT: A third plant in the Largo-Houston series was scheduled for completion in Gainesville, Florida on January 1, 1968. Design capacity is 150 tons per day and estimated cost is $1,500,000 or $10,000 per capacity ton.

The new plant at Gainesville is a demonstration project financed jointly by private funds, United States Public Health Service grants, and the University of Florida.

COST ESTIMATES FOR COMMERCIAL COMPOSTING IN MARICOPA COUNTY

In the tabulation below, cost data from modern commercial sized composting plants are listed and adjusted to estimates of factors for comparable salvage plants in Maricopa County in 1968:

300-TON PER DAY SALVAGE PLANT
ESTIMATED FIRST COST FACTORS

				Estimated Factors for Maricopa County in 1968			
				First Cost		Deprec'd	
Place	Year Opened	First Cost	Cap. Ton per Day	Total	Unit $ per Cap. Ton	Life Yrs	Cost ‡ $ per Cap. Ton
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		$		$	$		$
Houston	1967	1,700,000	300	2,100,000	7,000	15	1.82
Gainesville	1968	1,500,000	150	1,500,000	10,000	15	2.52
Phoenix	1963	1,500,000	175*	1,750,000	10,000*	5*	6.27
Phoenix	1963	1,500,000	300**	1,750,000	5,800**	5**	3.65

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* Dano rated capacity. Recorded life.
** Owner rated capacity. Recorded life.
‡ Includes interest at 4-1/2% per annum.

A Houston-type plant is designed for production of products and consists of a single production line. Dual lines would be necessary in a plant to insure reasonable continuity of operations in a disposal program. First cost for dual lines is estimated to be at least 60 percent higher or $2.91 per capacity ton. Actual cost per ton will vary with production tonnage. With dual production lines, production tonnage may approach rated capacity.

Estimated operating costs are listed in the tabulation below for a Houston-type plant in Maricopa County with dual production lines:

300-TON PER DAY SALVAGE PLANT

ESTIMATED DAILY OPERATING COSTS

		Man-Days	Rate $	
1.	Labor costs			
	a. Scales	1	24	24
	b. Feed operator	1	24	24
	c. Sorting labor	8	20	160
	d. Machine operators	5	28	140
	e. General labor	3	20	60
	f. Mechanic	1	28	28
	g. Secretary	1	16	16
	h. Laboratory technician	1	32	32
	i. Foreman	1	32	32
	j. Manager	1	45	45
	Subtotal, Labor			561
	k. Overhead	(30%)		168
	Total Labor			729
2.	Utilities and supplies			120
3.	Total operating cost			$849
4.	Unit operating cost (300 tons per day)			$2.83

The estimated unit first cost is $2.91 per ton, and the estimated unit operating cost is $2.83 per ton. $5.74 per ton is the estimated first cost plus operating cost of a 300-ton per day salvage plant in 1968 in Maricopa County.

At Houston direct salvage amounted to 23 percent of the 300 tons, or 69 tons per day. At unit cost of $5.74 per ton and 300 tons daily, cost would be $1,722. Unit cost of producing 69 tons of direct salvage would be $24.95 per ton.

In Maricopa County maximum reported sanitary landfill cost was $1.65 per ton (Phoenix, 1966-67). Salvage of 69 tons would save disposal cost at $1.65 per ton. Thus the estimated true cost of direct salvage is $23.30 per ton.

Without a compost market, compost would have to be disposed by sanitary landfill at $1.65 per ton. Disposal costs are estimated to be:

Disposal of 231 tons @ $1.65 =	$ 380
Salvage cost 300 tons @ $5.74 =	1,722
Total cost, 300 tons	$2,102
Unit cost	$7.00 per ton

SUMMARY OF DISPOSAL COSTS

A comparative tabulation is presented below:

COMPARISON OF ESTIMATED DISPOSAL COSTS

1968 - MARICOPA COUNTY

(Based on Plant Capacity of 300 Tons per Day)

	Land		First Cost		Operating Cost			Plant Waste Disposal				Disposal Unit Cost
			Total	Unit	Annual	Unit	Unit Cost		Tons per Day	Unit Cost	Weighted Cost	
	Acres	$	$	$ per Ton	$	$ per Ton	$ per Ton	%		$/Ton	$ / Ton	$ per Ton
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Salvage (Composting)	5	30,000	2,130,000	2.91*	265.737	2.83	5.74	70	210	1.68	1.18	6.92
Incineration	3	18,000	2,460,000	2.08*	242,400	2.56	4.64	20	60	1.68	0.34	4.98
Sanitary Landfill	40	120,000	335,000	0.78**	89,500	0.90	1.68	0	0	-	0.00	1.68

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* Depreciated in 15 years, interest at 4-1/2% per annum.

** Equipment depreciated in 5 years, interest at 4-1/2% per annum.

ADVANTAGES AND DISADVANTAGES OF DISPOSAL METHODS

Incineration or salvage requires less land than does sanitary landfill (opposite page, Col. 1). Total unit costs indicate that land cost (Col. 2) is not the most significant factor in any of the three disposal methods (Cols. 7 and 12).

First cost, land and plant (Col. 3), is about seven times higher for incineration or salvage than for sanitary landfill. Operating cost (Cols. 5 and 6) is about twice as much for incineration or salvage as for sanitary landfill.

Unit costs for land, plant, and operation (Col. 7) are from $3.00 to $4.00 per ton more by incineration and salvage than for sanitary landfill.

About 20 percent of incinerator feed becomes waste requiring disposal by sanitary landfill. Based on plant feed rate, 300 tons per day, unit cost for plant waste disposal is $0.34 per ton (Col. 11). Without a compost market in Maricopa County about 70 percent of 300 tons, 210 tons, is plant waste (Col. 8). Based on 300 tons of salvage plant feed, salvage plant waste disposal by sanitary landfill would cost $1.18 per ton (Col. 11).

In Column 12 estimated unit disposal costs indicate salvage cost exceeds sanitary landfill cost by $5.24 per ton and incineration cost exceeds sanitary landfill cost by $3.30 per ton.

Estimated daily cost of disposal by each of three methods is:

Salvage	300 tons x $6.92	= $2,076
Incineration	300 tons x $4.98	= $1,494
Sanitary landfill	300 tons x $1.68	= $ 504

Although the foregoing comparisons of disposal methods were presented as alternates, it is important to recall that incineration and salvage (composting) are not independent solid wastes disposal methods. In relation to all solid wastes of a community, incineration and salvage can accept only a selected fraction, and part of that remains plant waste. Disposal by the sanitary landfill method is the only sanitary method for all solid wastes. It is also substantially less expensive. It may also aid in land reclamation.

There is one place for municipal solid wastes incineration. Incinerators are practical where landfill sites are so remote from waste collection centroids that haul costs prohibit haul of combustible wastes directly to landfill. This includes special fractions of solid wastes such as trees and brush. Larger metropolitan areas than the one in Maricopa County may require incineration but must accept some compromise on air pollution.

There is theoretically one place for municipal salvage (composting) and that is where an adequate salvage market exists. Private salvage operations and federal government research programs are not considered municipal salvage operations.

TRANSFER STATIONS

As urban development enlarges the more congested part of a metropolitan area, cost increases for hauling solid wastes to ever more distant landfills. Total costs for solid wastes disposal include costs of collection, haul, and actual disposal.

Collection cost represents collection of solid wastes in trucks. Collection terminates either when a truck is full or when shift time ends. Haul begins when a truck starts from the collection area for the disposal site. Haul ends after a round trip where collection of the next load begins.

Elements of haul cost are indirectly related to length of haul and to location of overnight parking and service. Haul costs are related more directly to travel time. Where daily equipment, fuel, and labor costs are substantially fixed, the number of loads hauled per day determines the unit load cost. The average load weight then determines the average unit weight cost.

As the tonnage per truck load increases, unit haul cost decreases. As the haul labor cost decreases, the unit haul cost decreases. Minimum long haul cost is attained with one driver, maximum permissible highway load, and maximum number of round trips per day.

Transfer stations are facilities established at fixed locations to receive solid wastes from collection vehicles and transfer solid wastes into more efficient long-haul vehicles. Haul vehicles could be boats, barges, railroad trains, or trucks and trailers.

Significant benefits can result from proper application of transfer stations to some solid wastes collection-haul-disposal systems. Benefits from transfer to one-man, long-haul trucks may include the following:

1. Lowered total haul cost per ton.
2. Increased radius of practical haul distance; thus increased area in which to locate disposal sites.

3. Prolonged feasibility of sanitary landfill and delayed need for more expensive incineration.

4. Increased convenience for individual haulers and decreased promiscuous dumping.

5. Decreased vehicle congestion at the disposal site.

6. Decreased litter along haul routes by hauling in covered vehicles.

Compaction in haul vehicles can result in waste volume reduction. Volume reduction, by compaction in vehicles, is not as great as in incinerators for combustible solid wastes. Weight reduction is not accomplished by compaction. First costs and operating costs are less for transfer stations than for incinerators of equal tonnage capacity. Transfer stations may be considered as alternates to incinerators.

Orange County, California reported the total annual cost of a transfer station for 1,000 tons per day was $198,500. That is equivalent to $0.64 per ton. For 39 miles round trip from the transfer station to the disposal site, haul cost was $1.09 per ton. Average unit cost related to four transfer stations was $0.72 per ton for transfer and $0.92 per ton for haul. Total average unit cost for transfer and haul was $1.64 per ton.

Where long truck haul costs about $0.03 per ton-mile and collection truck haul costs about $0.12 per ton-mile, the difference, $0.09 per ton-mile, is the amount which indicates, approximately, the break-even point where transfer should be considered. Transfer in Maricopa County in 1968 would be based on less than 1,000 tons per day, and unit cost for transfer would be more than $0.72 per ton.

SECTION 3

POPULATION GROWTH

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SECTION 3

POPULATION GROWTH

GENERAL

Solid wastes accumulate by acts of the populace; the number of people in Maricopa County is therefore important to this study. Numbers of people in cities and towns must be estimated as one factor in determining the volume and weight of solid wastes to be expected at each place.

Unincorporated places, with typical urban population densities, pose similar physical problems although management of the waste disposal system may be different. The dispersed population creates a different physical problem in that its solid wastes accumulate dispersed as the population is.

All population studies selected for review in this study use reports of the United States Bureau of the Census as the record of past population counts. Population forecasts are under continuing study by both public and private agencies and for various purposes. A variety of methods are in use.

The Maricopa County Planning and Zoning Department is charged with the assignment of forecasting population growth of the County as a basis for coordinating plans for public service in future years. Their latest forecast is based upon a statistical method of the U S. Bureau of the Census.

The U. S. Bureau of the Census estimated "high birth rate" was selected for the purpose of obtaining a high projection ensuring adequate estimates of future needs. We accept this method as establishing an upper limit of population forecast for Maricopa County. We have modified this upper limit projection to conform to the "low birth rate," simply as another reference in our review.

Our review of forecasts has included those of the Valley National Bank, the First National Bank, Western Management Consultants, and Van Cleve and Associates.

AREAS

MAJOR CITIES: In this Report the term Major Cities means those incorporated cities having a population in excess of 30,000 at the time of the 1965 Special Census. Major Cities are Glendale, Mesa, Phoenix, Scottsdale, and Tempe. Staff members of these cities, and often assisted by consultants, report population studies and forecasts as a basis for estimating their future public service requirements.

Although each of these forecasts for a city is intended to be toward the upper limit, special emphasis is usually given to the study of individual census tracts, sections, or subdivisions. In this way a basis is established for planning utilities to serve certain areas. Thus studies for the Major Cities are usually summations of detailed studies of the parts. This method may be contrasted with succeeding divisions of the U.S. Census projections.

MINOR CITIES AND TOWNS: In this Report the term Minor Cities and Towns means those incorporated cities and towns having a population less than 30,000 at the time of the 1965 Special Census. Minor Cities and Towns are Avondale, Buckeye, Chandler, El Mirage, Gila Bend, Gilbert, Goodyear, Paradise Valley, Peoria, Surprise, Tolleson, Wickenburg, and Youngtown.

Factors tending to limit growth rate below the average for Minor Cities and Towns include simple isolation at Gila Bend and Buckeye. Increasing isolation is forecast at Wickenburg by scheduled rerouting of the highway. Decreasing isolation at Gilbert, Avondale, and El Mirage will occur with spread of the metropolitan population. As major traffic freeways are completed, physical isolation becomes less significant because of the reduction in time required to travel to the central area.

Accelerating growth rates for Peoria, Paradise Valley, and Tolleson seem inevitable and imminent because of their location on the fringe of the central urban area.

UNINCORPORATED CENTERS: Sun City and Litchfield Park represent unincorporated places of population whose high growth rates result from planning and aggressive promotion by private agencies. Sun City's programmed growth rate of 1,000 persons per year was apparently a modest target and is expected to be exceeded. Litchfield Park has a similar potential.

The Cave Creek-Carefree area is an example of an existing nucleus of population in an attractive but distant desert foothills location. A modest growth rate of 1,000 persons per decade is forecast for this area.

DISPERSED POPULATION: The Dispersed Population includes families on farms and ranches, crossroads service areas, recreation areas, and Indian reservations; military personnel at scattered sites;

etc. That population subtotal is nearly constant but may shift in location.

The significant increase in Dispersed Population is in response to development of housing tracts and trailer courts near population centers but detached from the urban area. As city limits are extended to include some of these developments, others form further away. Thus, there is no fixed location of this part of the population with passage of time.

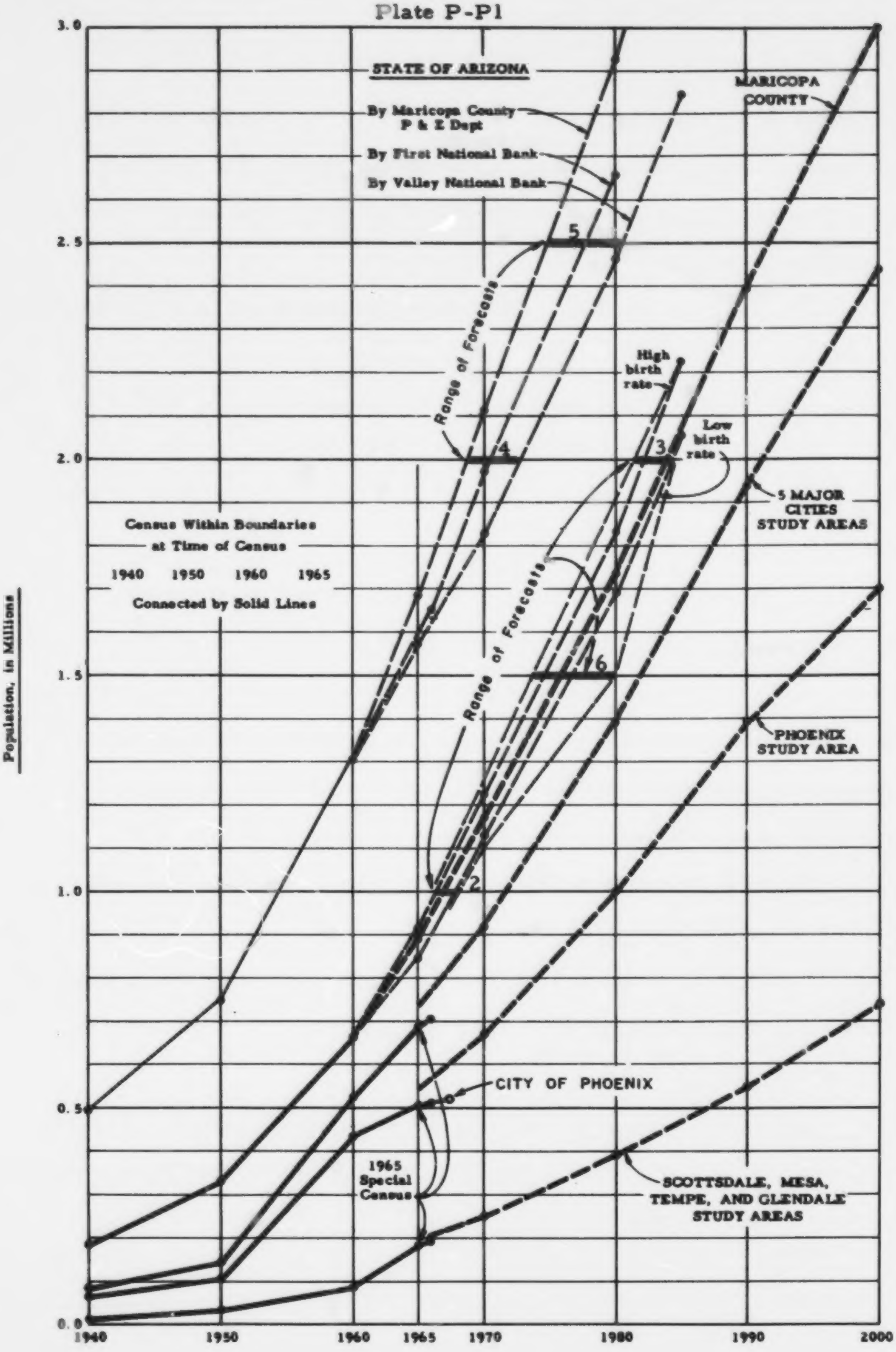
FORECASTS

Population records, as compiled by the U.S. Bureau of the Census, are included in this study and in all previous studies selected for review in this study.

City limits seldom remain unchanged for consecutive census counts, resulting in successive population counts for increasing areas but designated by the same names. It is common practice to plot successive census counts on graphs and connect those points by lines. This method has been used in this Report, but it should be noted that the line spanning a decade may be misleading if viewed as a growth rate, an average growth rate, or even an average growth rate for a larger area. Conversely, the straight line between points for a constant area is the average growth rate. Examples of constant areas would be the areas of states and counties.

Graphs for State and County population trends are presented on Plate P-P1. Long-term population projections are affected significantly by the relative effect expected from each factor in population growth. Therefore opinion becomes a major influence in population forecasts.

Plate P-P1



POPULATION TRENDS IN MARICOPA COUNTY

The range of forecasts (by others) for the State of Arizona indicates, primarily, a range of opinions. There is agreement that the State population will reach at least 2.5 million by 1980. The range of opinions is only five years.

The range of opinions on County population forecasts is also short:

1.0 million	2 years
1.5 million	6 years
2.0 million	3 years

The line designated "Maricopa County" on Plate P-P1 (Page S 3-5) indicates opinions formed during this study.

In reviewing population forecasts for communities within the County it appeared that the sum of the most optimistic forecasts for each place could result in an unreasonably high total for the County. Adjustment toward a less optimistic forecast for any place was made where comparison with forecasts for similar places indicated an overly-optimistic opinion without some reasonable basis.

Table P-T1 (Page S 3-8) is a summary of population records and forecasts for the five Major Cities.

Table P-T2 (Page S 3-8) lists population densities which would be achieved in the five Major City study areas in the year 2000 with the forecasted populations.

Table P-T3 (Page S 3-9) lists the selected population forecasts reviewed in this study for the five Major Cities: Glendale, Mesa, Phoenix, Scottsdale, and Tempe.

Table P-T4 (Page S 3-10) lists population records and forecasts for Minor Cities and Towns.

Table P-T5 (Page S 3-10) lists population estimates for Cave Creek, Sun City, and Litchfield Park, the selected unincorporated places in Maricopa County.

MAJOR CITIES

GENERAL: The five Major Cities are defined for this Report as those incorporated cities having a population count in excess of 30, 000 at the time of the 1965 Special Census. They are Glendale, Mesa, Phoenix, Scottsdale, and Tempe.

These cities share some common population growth factors and some common boundaries (Plate I-P5, Page S 1-7). Study areas (assigned in this study) for these cities are the contiguous, principal parts of the Metropolitan Study Area (Plate I-P5, Page S 1-7). The combined 1960 census for the five Major Cities (523, 600) was approximately 80 percent of the County population (663, 500). Their combined land area in 1960 was less than 4 percent of that of the County.

The population projection for the combined five Major Cities is the sum of the populations expected in each study area. Each study area is estimated to be larger than the corresponding city limits will be through the year 2000. Therefore the time of annexations is expected to affect neither the growth rate of any one of the five study areas nor the total for all of them.

Table P-T3 (Page S 3-9) lists selected forecasts for review in this study. The 15-year period from 1950 to 1965 was a time of

Table P-T1

SUMMARY OF POPULATION TRENDS IN MARICOPA COUNTY

Census and Forecasts in Thousands

Places	1950	1960	1965	1966**	1970	1980	1990	2000
Phoenix	106.8	439.2	505.7	511	670	1,000	1,393	1,700
Scottsdale	2.2*	10.0	54.5	58	70	110	155	200
Mesa	16.8	33.8	50.5	53	70	106	142	200
Tempe	7.7	24.9	45.9	48	65	95	130	180
Glendale	8.2	15.7	30.8	33	45	80	120	160
Subtotal 4 Cities	34.9	84.4	181.7	192	250	391	547	740
Subtotal 5 Major Cities	141.7	523.6	687.4	703	920	1,391	1,940	2,440
13 Minor Cities and Towns		39.1	49.8*		61	86	111	144
TOTAL for Incorporated Places		562.7	737.2*		981	1,477	2,051	2,584
Selected, Unincorporated Places		2.9*	12.0*		28	65	104	136
Dispersed Population, by Difference		124.4*	140.8*		161	197	240	280
TOTAL for Unincorporated Places		127.3*	152.8*		189	262	344	416
MARICOPA COUNTY	331.7	690.0	890*		1,170	1,739	2,395	3,000

Table P-T2

Population Densities in Year 2000 Major City Study Areas

Major City	Population (Year 2000)	Area (Acres)	Density (Persons per Acre)
Phoenix	1,700,000	282,000	6.0
Scottsdale	200,000	96,000	2.1
Tempe	180,000	32,000	5.6
Mesa	200,000	64,000	3.1
Glendale	160,000	29,400	5.5

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* Estimated this study

** Self estimate by city

Table P-T3

REVIEW OF POPULATION CENSUS AND FORECASTS
FIVE MAJOR CITIES IN MARICOPA COUNTY

Census and Forecasts in Thousands

	Census				Forecasts			
Report Prepared By (1)	1950 (2)	1960 (3)	1965 (4)	1966** (5)	1970 (6)	1980 (7)	1990 (8)	2000 (9)
PHOENIX								
U. S. Bureau of the Census	106.8	439.2	505.7					
1967 JCE Water Rights Study								1,500
1964 JCE Water System Study			600*		770			
1967 City of Phoenix, June				511	541	863	1,316	
1967 City of Phoenix, October			519**		628	931	1,080	
1959 Consultant Sewerage Study		380*	525*		657	900	1,050	
1959 Advance Plan. Task Force			550*		670	1,000		
1967 This Study					670	1,000	1,393	1,700
SCOTTSDALE								
U. S. Bureau of the Census		10.0	54.5					
1967 City of Scottsdale				58.4		110	155	
Consultant Study						110	155	
1967 JCE Water Rights Study								300
1967 This Study					70	110	155	200
MESA								
U. S. Bureau of the Census	16.8	33.8	50.5					
City of Mesa				53.2				
JCE, most recent Studies					70	106	142	300
This Study					70	106	142	200
TEMPE								
U. S. Bureau of the Census	7.7	24.9	45.9					
City of Tempe‡				48				
JCE, most recent Reports					47	74		200
JCE, this Study					65	95	130	180
GLENDALE								
U. S. Bureau of the Census	8.2	15.7	30.8					
City of Glendale				33				
JCE, most recent Studies					52	80		200
JCE, this Study					45	80	120	160

JCE John Carollo Engineers
* Estimate
** Self estimate by city
‡ 1975, 96,600; 1985, 157,500 — General Plan by consultant

Table P-T4

POPULATION RECORDS AND FORECASTS

THIRTEEN MINOR CITIES AND TOWNS

	Census Records			Forecasts in Thousands				
Place	1950	1960	1965	1966**	1970	1980	1990	2000
Avondale	2, 505	6, 151	6, 581		8	10	12	15
Buckeye	1, 932	2, 286	2, 400*		3	4	5	6
Chandler	3, 799	9, 531	12, 181	13	16	23	30	40
El Mirage		1, 723	3, 258	3	4	5	6	8
Gila Bend		1, 813	1, 938		2	3	4	5
Gilbert	1, 114	1, 833	1, 831		2	3	4	5
Goodyear	1, 254	1, 654	1, 821		2	3	4	5
Paradise Valley		2, 091	4, 650*		6	8	10	15
Peoria		2, 593	3, 802		5	8	11	15
Surprise		1, 574	2, 189		3	4	6	8
Tolleson	3, 042	3, 886	5, 000*		6	9	12	15
Wickenburg	1, 736	2, 445	2, 434*		2	3	3	3
Youngtown		1, 559	1, 709*	2	2	3	4	4
TOTAL	15, 382	39, 139	49, 794		61	86	111	144

Table P-T5

POPULATION ESTIMATES FOR

SELECTED UNINCORPORATED PLACES IN MARICOPA COUNTY

	1960	1965	1970	1980	1990	2000
Cave Creek	400	1, 000	2, 000	3, 000	4, 000	5, 000
Sun City	1, 500	9, 000	17, 000	30, 000	45, 000	50, 000
Litchfield Park	1, 000	2, 000	9, 000	32, 000	55, 000	81, 000
TOTAL FOR SELECTED UNINCORPORATED PLACES	2, 900	12, 000	28, 000	65, 000	104, 000	136, 000

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* Estimated for this study where 1965 special census was not reported.
** Self estimate by city or town.

increasing growth rate for each of these cities. The census records, however, are affected by a change in annexation philosophy which could lead to misinterpretation of growth rates.

CITY OF PHOENIX: In the 1950's studies of Phoenix population densities indicated a critical density of about seven persons per acre; near that density annexation of a less densely populated area would lower the average density. In 1950 the incorporated area was 17. 1 square miles and in 1957, 36. 3 square miles. The average annual increase was less than 3 square miles.

By 1960 the incorporated area was 187. 4 square miles resulting from an average annual increase of over 50 square miles. By 1965 the incorporated area was 245. 7 square miles, and the density was below 3. 5 persons per acre.

Concurrently neighboring cities expanded their boundaries. In this period Scottsdale was incorporated in time to be recognized in the 1960 census and, largely by annexations, became a city of 54, 500 people by 1965.

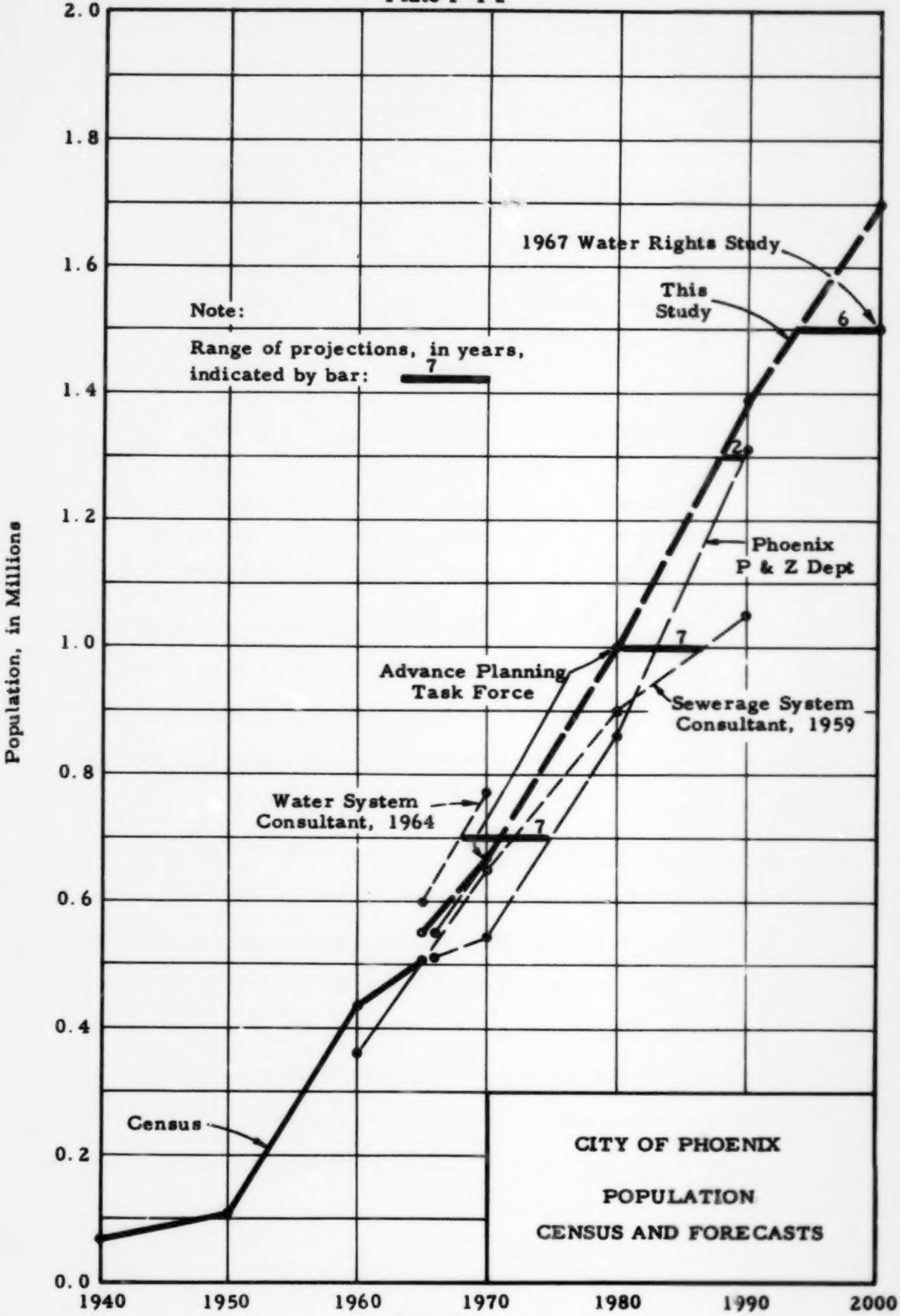
At present, stability has generally replaced expansion with agreement between the cities on common boundaries. These boundaries are the basis for designations of study areas in this Report.

Table P-T3 (Page S 3-9) lists the 15-year census record for Phoenix, results of five studies selected for review, and the opinion on population forecasts reached in this study.

The 1965 census is a reference point used to evaluate previous studies. The average annual increase in population for Phoenix was about 25,000 persons from 1950 to 1965. The census (505,700) was for the incorporated area. The study area population is estimated to have been between 525,000 and 550,000 in 1965. This conforms to the two 1959 studies. At 25,000 persons per year the Advance Planning Task Force estimate of 550,000 in 1965 would increase to 675,000 in 1970. Their forecast is accepted through 1980 simply because it has been reasonable since 1959, projects reasonably for a short period, and no significant factor is recognized to alter the 1980 projection of 1,000,000 persons.

The Phoenix study area contains about 282,000 acres. At 1,000,000 people the average density would be 3.5 people per acre. The effect of net immigration to Maricopa County is expected to far exceed the effect of a declining birth rate to the year 2000. The growth rate of the Phoenix study area is expected to increase until population density is high enough to affect that rate. At about 1.4 million people in 1990 the density would be about five people per acre. At 1.7 million persons in 2000 the density would be about six persons per acre. Relative to lower densities expected in the other four Major Cities they are expected to cause a decrease in the growth rate of the Phoenix study area some time after 1990.

Interpreting Plate P-P2 (Page S 3-13) may be done in two ways as a basis for predicting the amount of solid wastes to be expected in the future:



CITY OF PHOENIX

POPULATION

CENSUS AND FORECASTS

RANGE OF OPINIONS

(1)

Year	Population	Population Range
1970	541,000 - 770,000	229,000
1980	863,000 - 1,000,000	137,000
1990	1,050,000 - 1,393,000	340,000
2000	1,500,000 - 1,700,000	200,000

(2)

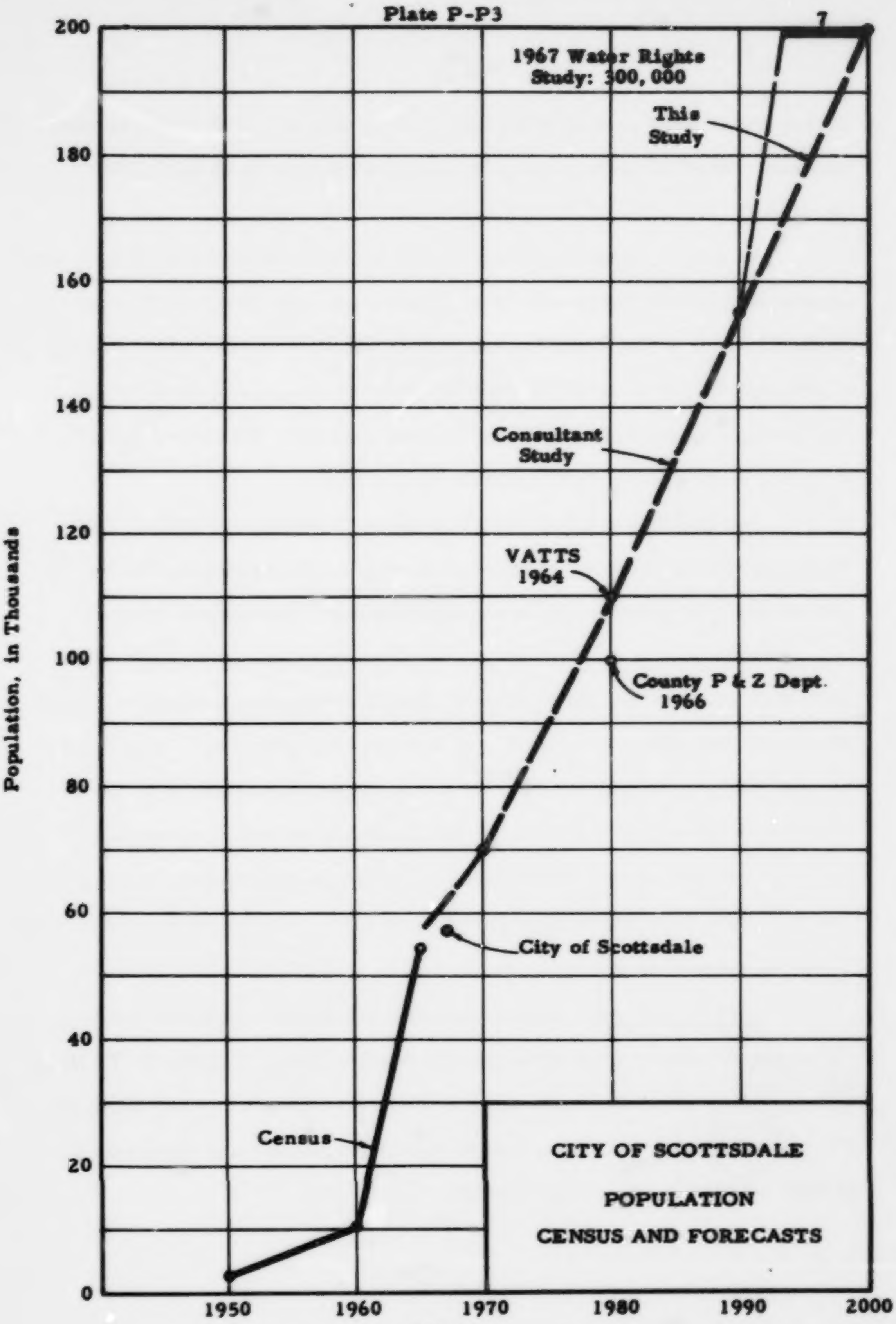
Population	Year	Time Range
700,000	1968 - 1975	7 years
1,000,000	1980 - 1987	7 years
1,300,000	1988 - 1990	2 years
1,500,000	1994 - 2000	6 years

It is evident that there is agreement that all predicted populations will be achieved; it is simply a disagreement on the time each step will be reached. The time range is two to seven years, a short time for planning purposes. The upper curve is considered to be adequate for planning purposes.

CITY OF SCOTTSDALE: Scottsdale was formed by incorporation of an urbanized area adjacent to Phoenix. From the first census in 1960 to the Special Census in 1965, the population grew from 10,000 to 54,500.

Table P-T3 (Page S 3-9) and Plate P-P3 (Page S 3-15) indicate the census record and forecasts. Forecasts by the consultant and a continuing study by the City of Scottsdale are based upon census tracts data as the incorporated area census record spans only five years, 1960 to 1965. The census record more nearly presents study area growth than

Plate P-P3



CITY OF SCOTTSDALE

POPULATION
CENSUS AND FORECASTS

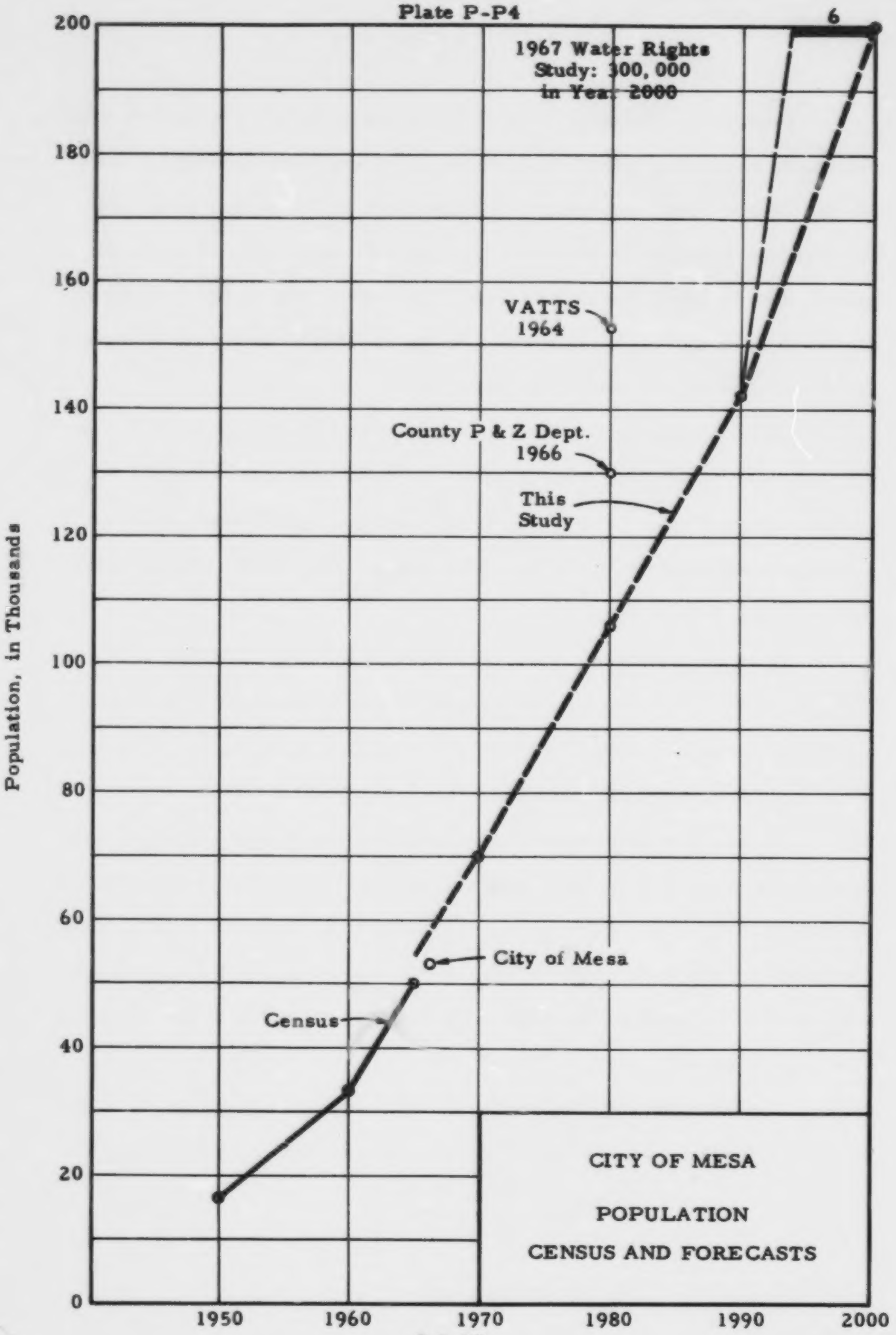
incorporated area growth when the 15-year period, 1950-1965, is considered. That period's average annual growth rate is about 3, 500 persons.

An average annual growth rate of 4, 000 persons from 1970 to 2000 is reasonable with reference to projected rates for Mesa and Tempe. Variation of this line from the consultant and City of Scottsdale studies would only be one year at 155, 000 population. Accepting those studies and increasing the annual average growth rate to 4, 500 completes the forecast in this study at 200, 000 in the year 2000.

The Scottsdale study area has about 96, 000 gross acres. The McDowell Mountains form a natural barrier to the northeast, tending to isolate about 60 percent of the study area from development until adequate traffic access is provided. The projected year 2000 population (200, 000) may occupy the estimated 40, 000 acres west and south of the McDowell Mountains at a density of five persons per acre. Therefore, no significant urbanization is expected in the northeast of the Scottsdale study area before the year 2000. (A tentative, private development program for this area was announced just before this Report went to press. This event demonstrates the need for continuing review of factors affecting population projections.)

CITY OF MESA: Census records for the City of Mesa and population projections for the Mesa study area are listed in Table P-T3 (Page S 3-9). The 1967 city limits and the study area limits are indicated on Plate I-P5 (Page S 1-7). A graph of population census and forecasts is plotted on Plate P-P4 (Page S 3-17).

Plate P-P4


6
1967 Water Rights
Study: 300,000
in Year 2000
VATTS
1964
County P & Z Dept.
1966
This
Study
City of Mesa
Census
CITY OF MESA
POPULATION
CENSUS AND FORECASTS
Population, in Thousands
200
180
160
140
120
100
80
60
40
20
0
1950
1960
1970
1980
1990
2000

Population studies for which Mesa projections were reviewed are related to recurring utility expansions. The average annual growth rate for the City of Mesa was about 2,200 persons in the period 1950-1965. Superstition Freeway is expected to be completed in time to affect the growth rate in the 1970-1980 decade. The effect will be to bring Mesa closer to Phoenix (in travel time). An increasing growth rate is forecast to a population of 200,000 in the year 2000.

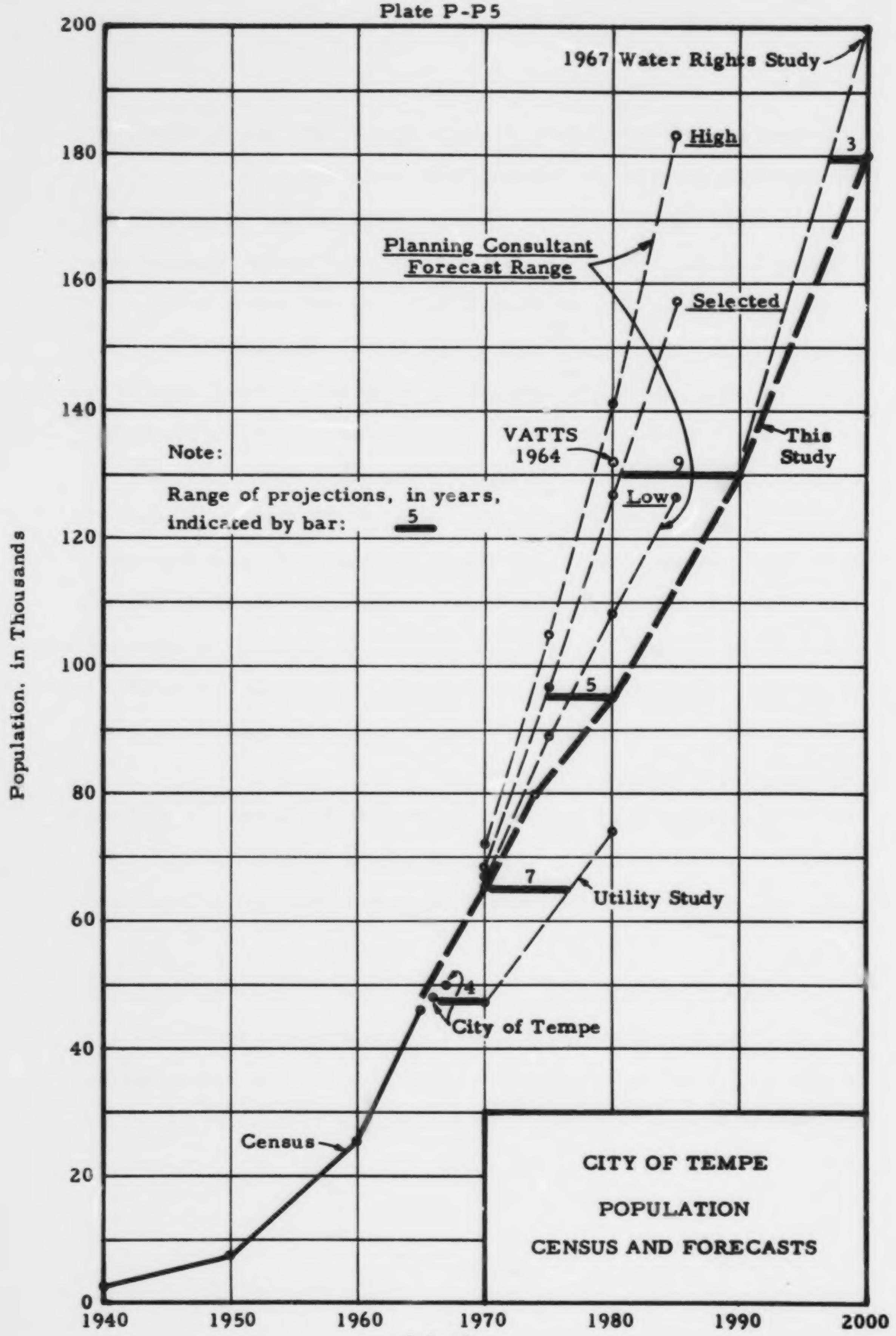
The 64,000 acres in the Mesa study area would accept 200,000 population at an average density of 3.1 persons per acre. But the initial growth is expected to be predominantly west and south resulting in an average population density of five persons per acre in the western two-thirds of the study area.

CITY OF TEMPE: Plate P-P5 (Page S 3-19) and Table P-T3 (Page S 3-9) present the City of Tempe census record and Tempe study area population forecasts. The 1967 Tempe City Limits and the Tempe study area limits are indicated on Plate I-P5 (Page S 1-7).

As this Report is written, discussions are continuing which will lead to agreements on logical future boundaries between Mesa, Tempe, Gilbert, and Chandler. These study area limits, assigned in this study, are based solely upon projected population densities and the corresponding need for the area to maintain projected rates of growth and expected direction of growth.

The average annual growth rate of Tempe was about 2,500 in the period 1950-1965. In addition to the growth rate factors common to the

Plate P-P5



CITY OF TEMPE

POPULATION

CENSUS AND FORECASTS

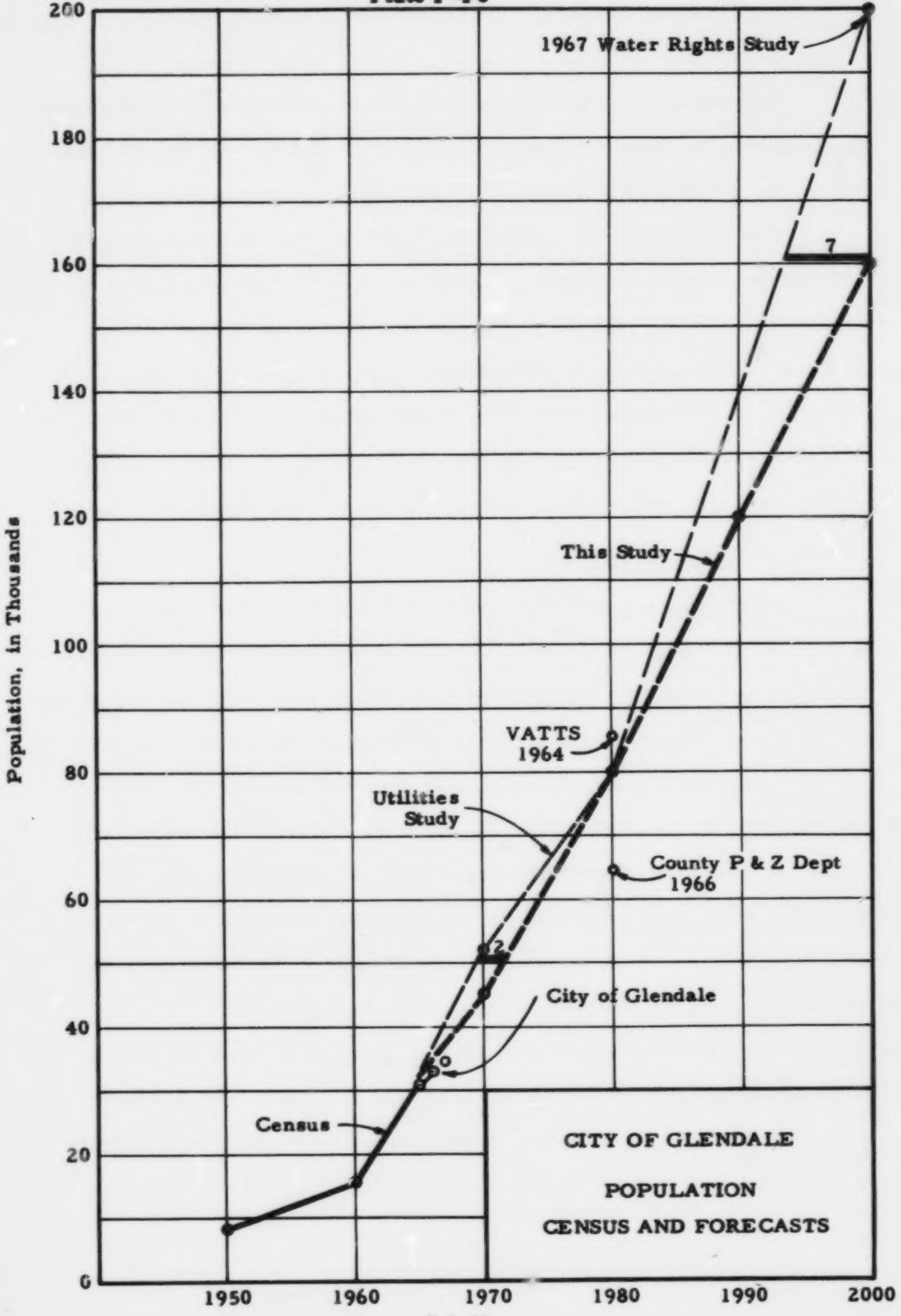
metropolitan study area cities, Tempe's growth rate was increased by the included growth rate of Arizona State University.

A 1967 planning report, "General Plan, Tempe, Arizona," was completed by the consultant in time to be included in this review of forecasts. Their high, low, and selected forecasts are plotted on Plate P-P5 (Page S 3-19). The range of time projected for a population of 65,000 is about one year, and 80,000, two years. At 95,000 the time range is five years and at 130,000, nine years. The variation in opinions results from judgment of the effect produced when Arizona State University reaches its planned maximum enrollment of 30,000 students in about 1974. The consultant opinion assumes a continuing increase in growth rate without the influence of the University growth. This study assumes a six-year period will be required to achieve the preceding growth rate. In addition, this study projects growth rate in the decade 1990 to 2000 at 5,000 persons annual average as being reasonably comparable to rates projected for Scottsdale and Mesa.

The Tempe study area contains about 35,000 acres. A population of 180,000 would result in an average density of about 5.1 persons per acre, comparable to that expected in the western part of the Mesa study area.

CITY OF GLENDALE: Plate P-P6 (Page S 3-21) and Table P-T3 (Page S 3-9) present the City of Glendale census record and Glendale study area population forecasts. The 1967 Glendale City Limits and the Glendale study area limits are indicated on Plate I-P5 (Page S 1-7).

Plate P-P6


Population, in Thousands
0
20
40
60
80
100
120
140
160
180
200
1950
1960
1970
1980
1990
2000
1967 Water Rights Study
7
This Study
VATTS
1964
Utilities
Study
County P & Z Dept
1966
2
City of Glendale
Census
CITY OF GLENDALE
POPULATION
CENSUS AND FORECASTS

The utility study population projection varies only two years from the projection in this study for a population of 50,000. At 160,000 population, the difference of opinion is seven years.

The study area contains about 29,400 acres. At a population of 160,000 the average population density would be 5.5 persons per acre.

The average annual growth rate in the 15-year period between 1950 and 1965 was about 1,500 persons. An accelerating growth rate is projected to reflect the effect of the northwesterly growth of Phoenix continuing across the common borders with Glendale. An average annual growth rate of 4,000 persons is projected for two decades, 1980 to 2000.

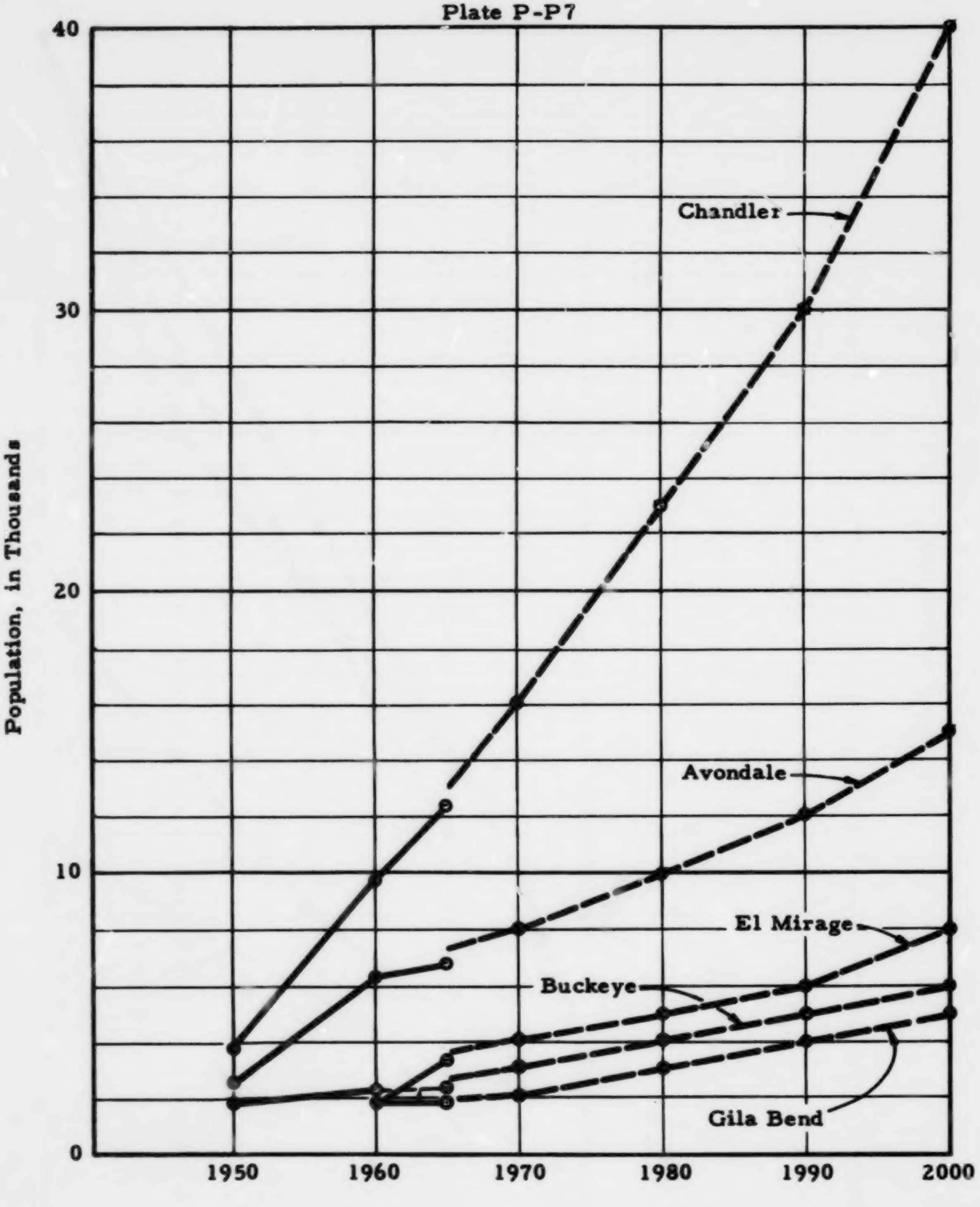
MINOR CITIES AND TOWNS

GENERAL: The classification Minor Cities and Towns has been designated in this Report to include the thirteen incorporated places having a population of less than 30,000 at the time of the 1965 Special Census. The study areas for these places are indicated on Plate I-P5 (Page S 1-7), except for Gila Bend and Wickenburg which are remote from the Metropolitan Study Area (see Plates I-P6 and I-P7, Pages S 1-8 and S 1-9).

Although the population of each of these places is minor, as defined herein, and of all thirteen only Chandler is projected to exceed 30,000 by the year 2000, sanitary disposal of solid wastes is a nearly impossible financial problem for each minor city or town.

Table P-T4 (Page S 3-10) presents census records and population projections for each minor city or town, and the totals. Plates P-P7 through P-P10 (Pages S 3-23 through S 3-26) are graphic presentations of the data listed in Table P-T4 (Page S 3-10).

Plate P-P7

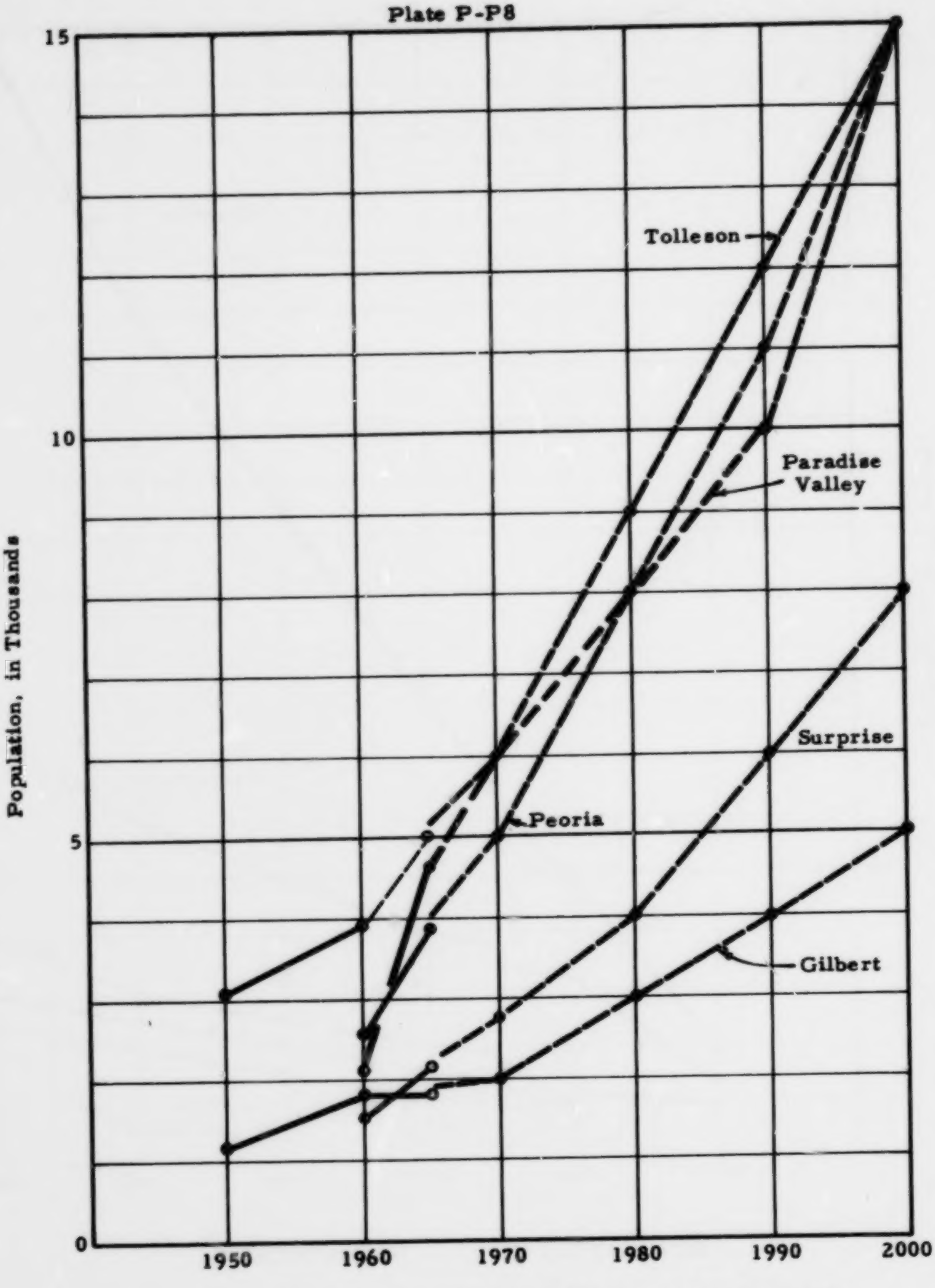


POPULATION CENSUS AND FORECASTS

MINOR CITIES

Avondale Buckeye Chandler El Mirage Gila Bend

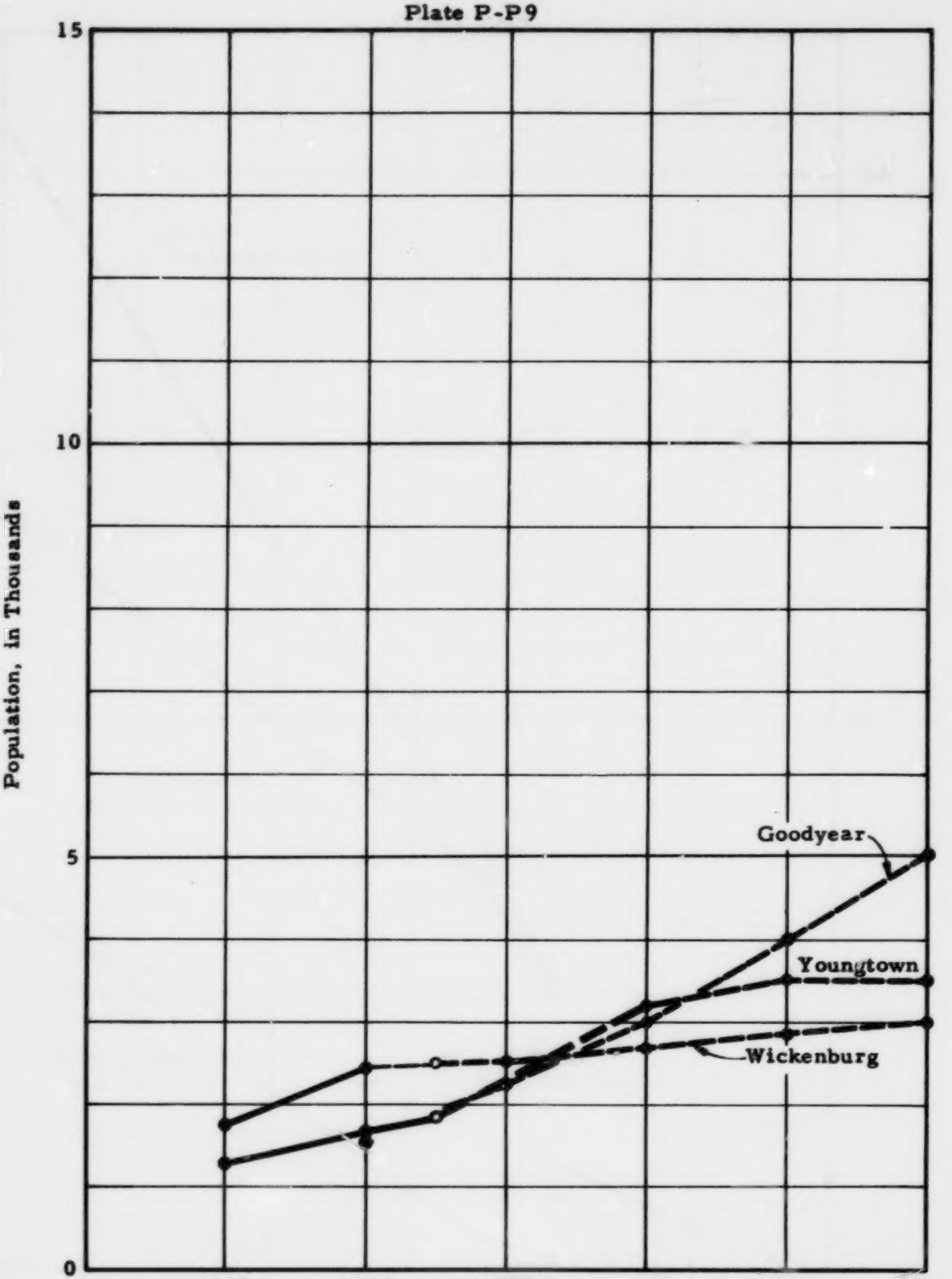
Plate P-P8



POPULATION CENSUS AND FORECASTS - MINOR CITIES

Gilbert Paradise Valley Peoria Surprise Tolleson

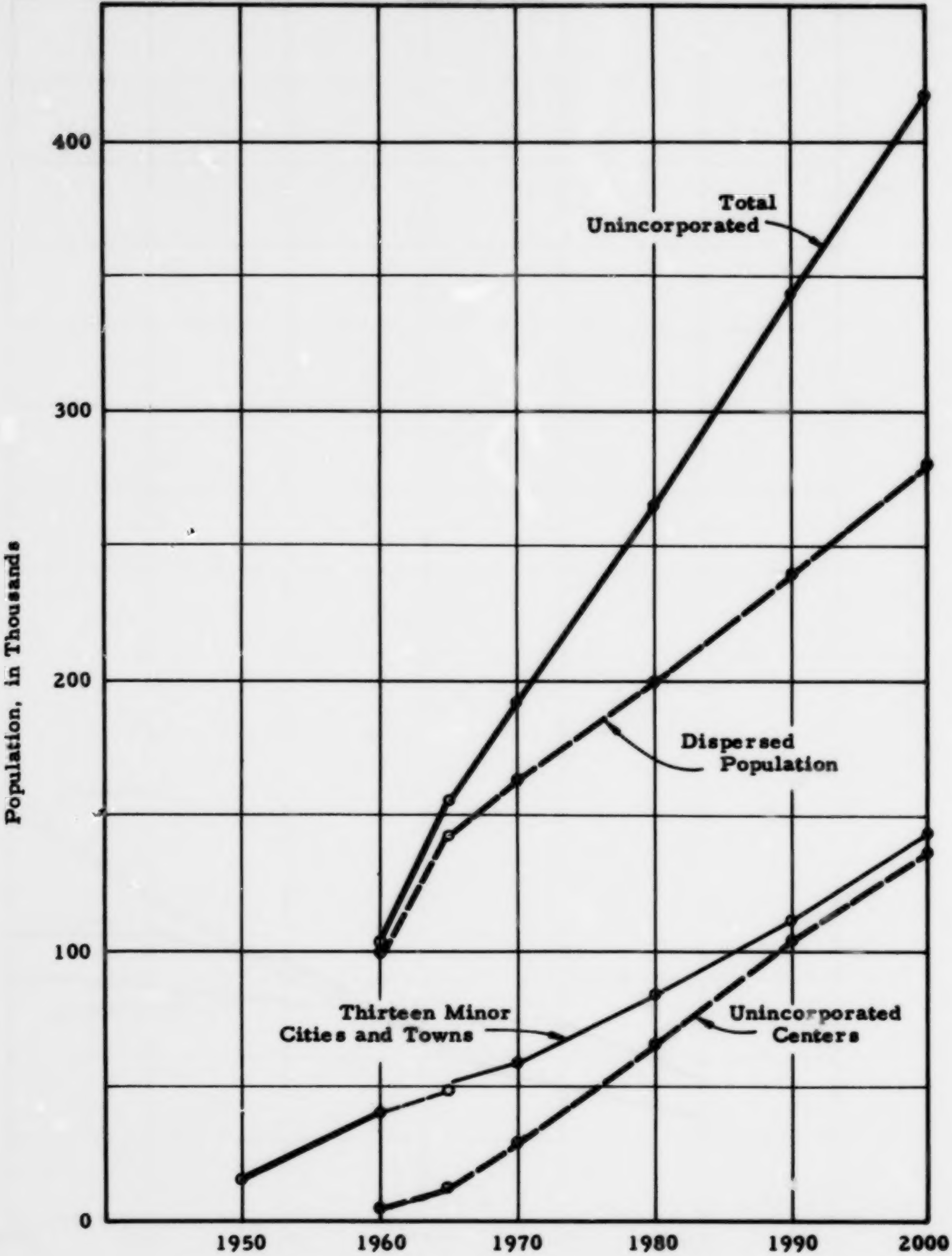
Plate P-P9



POPULATION CENSUS AND FORECASTS - MINOR CITIES

Goodyear Wickenburg Youngtown

Plate P-P10



POPULATION CENSUS AND FORECASTS
THIRTEEN MINOR CITIES & TOWNS & UNINCORPORATED PLACES
IN MARICOPA COUNTY

Plate	Minor Cities and Towns
P-P7	Avondale, Buckeye, Chandler, El Mirage, Gila Bend
P-P8	Gilbert, Paradise Valley, Peoria, Surprise, Tolleson
P-P9	Goodyear, Wickenburg, Youngtown
P-P10	Thirteen Minor Cities and Towns and Unincorporated Places in Maricopa County

CHANDLER: The average annual growth rate in the Chandler study area was about 600 persons in the 15-year period from 1950 to 1965. In 1967 the study area population was estimated at about 14, 000. This estimate is based upon an actual house count made during a study of the water and sewerage systems.

Population projection was made at an average annual growth rate of 700 persons to 30, 000 in the year 1990. The rate was increased to 1, 000 persons in the decade between 1990 and 2000.

The Chandler study area contains about 15, 400 acres; at a population of 40, 000, the average population density will be 2. 6 persons per acre.

AVONDALE, PARADISE VALLEY, PEORIA, AND TOLLESON: These four municipalities are expected to attain populations of 15, 000 persons by the year 2000. Census records and population projections are listed below from Table P-T4 (Page S 3-10). The projections are populations expected in the respective study areas.

Place	Population				
	1960 Census	Projection in Thousands			
		1970	1980	1990	2000
Avondale	6,151	8	10	12	15
Paradise Valley	2,091	6	8	10	15
Peoria	2,593	5	8	11	15
Tolleson	3,886	6	9	12	15

The average annual growth rate varies for the four municipalities and through 30 years from 200 to 500 persons.

The steady growth rate of Avondale is expected to be favorably influenced by the growth rate of Litchfield Park and development of a satellite Phoenix airport and a satellite campus of Arizona State University nearby. By 1990 the westward development of Phoenix and Tolleson should have a similar effect on an increasing growth rate for Avondale. At about 5,000 acres and a population of 15,000 the average population density would be 3.0 persons per acre in the Avondale study area.

Tolleson lies in the path of the westward growth of Phoenix and the eastward growth from Litchfield Park. The study area contains about 7,700 acres; when a population of 15,000 persons is attained, the average population density will be only 1.2 persons per acre.

The Peoria study area contains about 10,000 acres in a location favoring rapid population growth before the year 2000. With Sun City developing rapidly to the west and Glendale to the east and south, accelerating growth of Peoria may lag its neighbors but seems inevitable. The projected average annual growth rate is 300 persons in the period from 1970 to 1990. When their 10,000 acres is occupied by 15,000 people, the average population density will be only 1.5 persons per acre.

Paradise Valley is enclosed by neighboring Phoenix and Scottsdale. The average annual growth rate is projected to reach 500 persons by 1980. Planned for low density land use, Paradise Valley would still not reach saturation when, at about 10,000 acres with 15,000 persons, an average population density of 1.5 persons per acre would be reached.

EL MIRAGE, GOODYEAR, GILBERT, SURPRISE, AND YOUNGTOWN: These five municipalities are each expected to have populations of 5,000 to 8,000 by the year 2000. Separated from Phoenix by at least two intervening cities their growth rates are not expected to respond directly to metropolitan growth radiating from Phoenix. Their census records and population forecasts are recounted below from Table P-T4 (Page S 3-10).

	Population				
		Projection in Thousands			
Place	1965 Census	1970	1980	1990	2000
El Mirage	3,258	4	5	6	8
Goodyear	1,821	2	3	4	5
Gilbert	1,831	2	3	4	5
Surprise	2,189	3	4	6	8
Youngtown	1,709	2	3	4	4

The Youngtown population projection is simply a statement of their own plan to limit growth to about 3,500 persons within their present area limits.

El Mirage and Surprise are nuclei of an area developing west of the Agua Fria River on U.S. Highway 60-70-89. The average annual growth rate for each is projected at 100 to 200 persons. When either attains a population of 8,000 persons in a study area of 3,200 acres, the average population density will be 2.5 persons per acre.

The Gilbert study area on the southeastern edge of the metropolitan developing area should plan for an accelerating growth rate with construction of the Superstition Freeway providing improved access to Mesa, Tempe, and Phoenix. The projected average annual growth rate is 100 persons. The study area contains about 7,700 acres; when the population reaches 5,000, the average population density will be only 0.7 persons per acre.

The eastern and southern limits of the Gilbert study area were chosen arbitrarily. The only significance of the low average population density is that there is adequate space for the predicted growth.

The Goodyear population projection at an average annual rate of 100 persons recognizes the same growth factors foreseen for Avondale, adjacent to the west. From a lesser 1965 census base, 1,821 for Goodyear and 6,151 for Avondale, similar rates of growth would result in a continued lag of the Goodyear population as compared to Avondale's.

When 5,000 persons occupy the 2,000 acres in the Goodyear study area, the average population density will be 2.5 persons per acre.

Recognition has been given to efforts to attract residents to Litchfield Park rather than to encourage growth west of the present Goodyear limits.

BUCKEYE, GILA BEND, AND WICKENBURG: Buckeye, Gila Bend, and Wickenburg are not within the Metropolitan Study Area, are isolated from other population centers, and their projected modest growth rates are reflections of their isolated locations.

Buckeye and Gila Bend are centers of agricultural activities along U.S. Highway 80 between Phoenix and Yuma. Whereas most of the incorporated and unincorporated places in the Metropolitan Study Area grow as a result of their total effort, sharing in each other's gains, isolated places must provide their own impetus.

Gila Bend and Buckeye are each projected at an average annual population growth rate of 50 persons.

Roadside services have been a significant economic factor for Wickenburg, but construction of a proposed new highway routed away from Wickenburg is expected to adversely affect the population growth rate. Agriculture, winter visitors, and retirement residents are factors expected to maintain the present population.

Census records and population projections for the thirteen Minor Cities and Towns are accumulated in Table P-T4 (Page S 3-10). These figures are plotted on Plate P-P10 (Page S 3-26) for graphic comparison with total unincorporated populations in the County.

UNINCORPORATED CENTERS AND DISPERSED POPULATION

Table P-T5 (Page S 3-10) presents population estimates and projections for Cave Creek, Sun City, and Litchfield Park. These three places were selected as representative of developing centers within the areas of dispersed population.

Cave Creek is a center of about 1,000 population in 1965 and is exhibiting a significant growth rate in response to community promotional efforts. This effort originates, principally, with residents and internal organizations as other cities in the County have, historically, promoted themselves.

Sun City is a community planned to develop from open farm land and desert. Planning, promotion, and control are, principally, by private initiative external to the community area. The scheduled rate of growth was 1,000 persons per year and this rate has been achieved. An accelerating growth rate to 1,500 persons per year is projected to 1990.

Litchfield Park is another privately planned and developing project which is projected, in this Report, to attain an annual average growth rate of 2,300 persons between 1970 and 1990.

These three centers of population are indicative of possible future centers which may develop and look to the County level of government for a solution to their solid wastes disposal needs.

Dispersed populations in future years make up the difference between projected County population and the total population projected for all other places within the County. Speculation as to exact locations of future centers is not warranted, except to note that strip areas are developing along highways and freeways, for example, east of the City of Mesa.

SECTION 4

SOLID WASTES DISPOSAL OPERATIONS IN MARICOPA COUNTY

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SECTION 4

SOLID WASTES DISPOSAL OPERATIONS IN MARICOPA COUNTY

DISPOSAL

DEFINITIONS: The following definitions of disposal methods and/or facilities are given to provide a basis for classifying disposal practices in this study:

1. Sanitary landfills are places on land filled with solid wastes and covered with earth daily by controlled methods in accordance with an engineering plan which precludes the creation of health hazards, obnoxious odors, or conditions offensive to sight.
2. Landfills are places on land filled with solid wastes and covered with earth.
3. Dumps are places where solid wastes are dumped and left uncovered. Burning dumps are places where combustible wastes are dumped and burned.
4. Incineration is a process in which the combustible fraction of solid wastes is burned in an incinerator plant.
5. Grinding food wastes is a process in which garbage is mechanically reduced in particle size and flushed into the sewerage system.
6. Other disposal practices include the following subordinate processes:
   - a. Salvage is a process in which some useful fraction is separated from useless solid wastes and marketed. Examples include metals, rags, paper, and glass.
   - b. Composting is a process in which solid organic wastes are altered by aerobic or

anaerobic decomposition producing a stable product.

c. Rendering is a process in which animal bodies are reduced to useful products including fertilizers, glues, oils, glycerin, soaps, and detergents.

d. Reduction is a process in which garbage is cooked to useful products including, principally, grease

e. Waste heat reclamation is a process in which heat produced in an incinerator is used for a beneficial purpose.

f. Land reclamation is a process in which land surface is shaped by landfill to increase its potential uses.

g. Shredding is a process in which solid wastes are mechanically reduced in particle size as a preliminary step in ultimate disposal.

h. Dehydration is a process in which moisture is removed from garbage in preparation for temporary storage.

SOURCE OF DISPOSAL DATA IN MARICOPA COUNTY: Questionnaires were mailed to each city and town in Maricopa County with the request that all questions be answered as completely as possible. Telephone calls and/or personal visits were made to each municipality to obtain the disposal data made available. In addition a copy of another questionnaire was sent to each private collector with a request for their cooperation in the study. These were followed by personal visits where possible.

Contacts with the Maricopa County Health Department were sources of additional data. Agricultural Departments of Arizona State University and the University of Arizona were questioned. Representatives of private industries responded to our questions.

Responses from the sources named above were supplemented by study trips to disposal sites.

SANITARY LANDFILLS: In midyear 1967 only two operating municipal disposal sites in Maricopa County could be classified as sanitary landfills. They were operated by Glendale and Tempe. Data listed in the following tabulation was provided by each city respectively:

SANITARY LANDFILL DATA, MIDYEAR, 1967

	Glendale	Tempe
Land ownership	Private	Municipal
Operated by	Glendale	Tempe
Location	Peoria Ave at 103rd Avenue	Salt River at Hardy Drive
Type	Natural depression, cut, and cover	Pit, cut, and cover
Size	13 Acres	40 Acres
Volume received	600-700 cu yds per day	500 cu yds per day average
Rate of filling	Not reported	Unknown
Probable life	One year	Unknown
Fees charged	See schedule in Table R-T16 (Page S 4-69)	Residential: free Commercial and industrial: 0-4 cu yds $1.00/cu yd; over 4 cu yds $0.50/cu yd
Interagency agreements	Joint use of Glendale sanitary landfill by Glendale, Peoria, El Mirage, Surprise, Youngtown, and County	Tempe and County including Guadalupe

Glendale has a dump of piled brush at the old sewage treatment plant site at 99th and Glendale Avenues. This dump is inactive. It is a fire hazard and unsightly.

In early 1968 Phoenix has converted all three disposal sites from landfills to sanitary landfills.

Data listed in the following tabulation was provided by the City of Phoenix:

PHOENIX LANDFILL DATA, MIDYEAR, 1967

	15th Avenue	16th Street	19th Avenue
Land ownership	Private	Private	Municipal
Operated by	Phoenix	Phoenix	Phoenix
Location	At Salt River	At Salt River	At Greenway Rd
Type	Pit	Pit, cut, & cover	Pit, cut, & cover
Size	320 gross acres	37 acres	140 acres
Average day tonnage	615	258	450
Rate of filling*	1,300 cu yd/day	550 cu yd/day	950 cu yd/day
Probable life	2 years	4 years	5 years
Fees charged**:		City trucks only	
Class I:			
0 to 1-1/2 tons	Free		Free
1-1/2 to 3 tons	$2.50		$2.50
over 3 tons	$5.00		$5.00
Class II:	$10.00 min.		$10.00 min.
Class III:			
0 to 1,500 gallons	$0.75		$0.75
over 1,500 gallons	$2.50		$2.50
Interagency agreements	None		Maricopa Co.

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*Calculated, based on test result: 1 ton occupies 1.9 cubic yards.

**For wastes normally placed by regular equipment, termed Class I; oversize wastes, Class II; liquids, Class III.

LANDFILLS: Avondale operates a landfill which is also used by Goodyear and the County. Brush is piled in one part of the pit. Tires are piled on cover material. Household and commercial wastes are compacted in another part of the pit and are covered every other day. Final disposal of the brush has not been reported, but the exposed dry brush is a fire hazard. Avondale did not report data on their operations. Goodyear did not report data on their operations. The landfill serving both communities is located about three miles south of the U.S. Highway 80 Agua Fria Bridge in a borrow pit.

A privately owned landfill at 40th Street and the Salt River is reported to accept "trash" only and no "garbage." This landfill is located in a borrow pit. No other data was reported.

Another privately owned landfill is located near Central Avenue and the Salt River. It is reported to accept no garbage. No other data was reported.

Maricopa County operates four landfills. One, in the Cave Creek area, is a trench type operation. It has a nuisance-level fly population. Another is in the Hassayampa Valley ten miles west of Buckeye. Another is about three miles north of Gila Bend. The Gila Bend landfill has the disadvantages of a burning dump except that it is covered bi-weekly. Burning prevents access to insects and rodents. The County's fourth landfill is near Aguila. These four sites share the services of a small, track dozer, pickup truck and trailer for compacting wastes in place and placing earth cover on a bi-weekly schedule.

BURNING DUMPS: Buckeye operates a burning dump near the Salt River at 1st Avenue. Buckeye has not reported data on their operations. The dump is air polluting, odorous, unsightly, and unsanitary.

Tolleson operates an open dump which burns frequently. This dump is located at 91st Avenue near the Salt River. Tolleson has reported no other data on its operations.

Wickenburg operates a burning dump in a rocky canyon about two miles southwest of the Town. It is air polluting, odorous, unsightly, and unsanitary. Wickenburg reported the following data:

Ownership	Arizona State Land Department (Ten-year lease)
Location	W 1/2, NE 1/4, Sec. 14, T 7N
Type	Canyon side
Size	80 acres (gross area)
5-day tonnage	25
Rate of filling	Unknown
Probable life	Remaining lease, 7 years
Fees charged	None
Interagency agreements	None

DUMPS: Five dumps were observed at the locations listed below. Ownership and operation have not been identified.

1. Dysart Road at Thomas Road
2. Glendale Avenue at Agua Fria River
3. Glendale Avenue at New River
4. Glendale Avenue at El Mirage Road
5. Miller Road at north bank of Salt River

Unauthorized, promiscuous dumping is common in less densely populated areas bordering the more densely populated areas. Locating all places would require, at least, aerial photography of the County! These dumping sites are unsightly, unsanitary, fire hazards, and illegal. One hundred twenty specific locations are reported by the staff of the Maricopa County Health Department, as indicated in the following listing:

UNAUTHORIZED, PROMISCUOUS DUMPING SITES IN MARICOPA COUNTY

Reported by the Maricopa County Health Department
District Offices
June 8, 1967

CENTRAL OFFICE DISTRICT

1 Flood control dams N of Bell Road - 41st Street area (50 pickup truck loads)

2 On W side of 40th Street and on the N side of the Arizona Canal - behind Phoenix Day School (3 truckloads scattered around)

3 32nd Street from San Miguel to Lincoln Drive

4 From Dreamy Draw Drive to 32nd Street and from Northern Avenue to Glendale Avenue

5 40th Street and ____________________

6 7th Street and Bell Road

7 44th Street and McDonald Drive

8 On E side of Scottsdale Road at Cactus Road

9 64th Street N of Larkspur

10 Shea Boulevard near 108th Street

11 Northern Avenue, Hatcher Road and Dreamy Draw Drive area

12 40th Street and Cactus Road

13 40th Street and Thunderbird Road

14 23rd Avenue - 0.3 mile north of Williams Drive

15 43rd Street, N of Union Hills Drive

16 40th Street, N of Union Hills Drive

17 32nd Street and Utopia - both sides of road

18 S of Union Hills Drive and E of Cave Creek Road 0.3 mile (27th Avenue and Union Hills)

19 Area N of Union Hills Drive between 20th Street and 16th Street

20 7th Street and Beardsley Road

21 7th Street - 1 mile N of Bell Road (7th St W along power line 0.4 mile)

22 Cave Creek Dam Road - 0.4 mile W of Cave Creek Road

23 19th Avenue, N of Williams Drive

24 Cave Creek Wash - from Cactus Road to Thunderbird Road

25 19th Avenue, W of Union Hills Drive

26 7th Street and Cactus Road (W side - across from gun range)

MESA DISTRICT

1 E of corner of Brown Road and Signal Butte Road

2 S side of University Drive between Ellsworth Road and 88th Street (E of Knolls)

3 N side of Taft School

4 W side of Taft School

5 Big wash - E side of North Crismon Road

6 Two dumps on S side of road leading from Crismon - directly W of Old Bush Highway near Granite Reef Mountains

7 N of the N side of two houses on 104th Street, S of Brown Road

8 E of Signal Butte Road a little N of red post

9 N end of Ellsworth Road next to mountains

10 N of University Drive between Signal Butte Road and County Line Rd

11 One-eighth mile N of McDowell Road on E side of N Higley Road

12 S end of 84th Street, S of Stevensville Trailer Court

13 N end of Alma School Road

14 N of San Tan Boulevard on Recker Road - Chandler Heights

15 N of McDowell Road between Greenfield Road and Higley Road

16 N end of Lindsay Road, 1/4 mile (large area)

17 Hayden Road and 1st Street - in back of Ray Sheet Metal Works

18 Mesa Drive and McDowell Road - in Lehi - 200 yards north (two pickup truck loads)

19 McKellips Road - east of Hayden Road one mile - ditch runs S of McKellips Road - ditch full of garbage

20 W side of Scottsdale Road and riverbottom - N side of University Stadium (one truck load scattered around)

21 Beverly Road to Warner Road, 56th Street to 36th Street (South Phoenix District also)

22 E side of 56th Street from Elliott Road to 1/2 mile S

23 32nd Street and Williams Field Road

24 Ocotillo Road and McQueen Road

25 From Ocotillo Road to Queen Creek Road - on both sides of McQueen

26 N side of Ray Road - E of Val Vista Road

27 Bush Hwy to Meridian Road and from Broadway to Baseline Road

28 On both sides of University Drive in the vicinity of 88th Street

29 On both sides of Church Road (Crismon Road) from Brown Road to McDowell Road

30 From Higley Road to Recker Road and from McDowell Road to ______

31 Lehi and Gilbert east

32 From Lindsay Road to Val Vista Road and from McDowell to Lehi Rd

33 Hunt Hwy - U.S. 87 east

34 Hayden Road and the riverbottom

35 Hayden Road to Pima Road and from McKellips Rd to Roosevelt St

36 On both sides of Queen Creek Rd from McQueen Rd to Cooper Road

Queen Creek Area

37 On W side of Power Road at Ocotillo Road

38 On W side of Rittenhouse Road, 1/3 mile N of Cloud Road

39 One-half mile W of Hawes Road on N side of Chandler Heights Road

Chandler Heights Area

40 On N side of Superstition Road, W of Higley Road

41 On S side of Hunt Hwy near Sossman Road (in Pinal County)

42 On S side of Hunt Hwy E of Ellsworth Road (in Pinal County)

Eight to ten labor camps have been "written up" for dumping near the workers' quarters. At least half a dozen small dump sites are scattered in unreclaimed desert in the southwest part of Maricopa County. Two listings made of dump sites in Pinal County because the majority of dumpers are from Queen Creek and Chandler Heights.

GLENDALE DISTRICT

1 91st Avenue and the riverbottom (3 or 4 pickup truck loads)

2 107th Avenue and the riverbottom (3 or 4 pickup truck loads)

3 109th Avenue and the riverbottom (3 or 4 pickup truck loads)

4 117th Avenue and the riverbottom (3 or 4 pickup truck loads)

5 117th Avenue - N of Northern Avenue (car loads - Sun City)

6 El Mirage Road and Indian School Road

7 107th Avenue, south of Broadway

8 91st Avenue and Salt River

9 Thomas Road, W of 115th Avenue (Agua Fria River)

10 El Mirage Road, 1/4 mile N of Indian School Road (on E side)

11 On N side of McDowell Road, W of 195th Avenue (White Tanks)

12 On S side of Olive Avenue at New River Road

13 On E side of 99th Avenue between Indian School Rd and Camelback Rd

14 On Thomas Rd, 1/4 mile E of Dysart Road (old Litchfield dump)

15 Indian School Road and Agua Fria

16 On Agua Fria between Northern Avenue and Olive Avenue

17 Agua Fria River - from Grand Ave at bridge to Olive Ave and 115th Ave with entrances also from Youngtown

18 SE of Surprise at end of El Mirage Rd and at end of Greenway Road

19 Wittman dump - E of Wittman near school

20 Circle City dump - W end of Circle City

21 Morristown dump - 1 mile up Castle Hot Springs Road

22 Wickenburg dump - Wickenburg

23 W end of Olive Avenue

24 Waddell Road and Beardsley Canal

25 125th Avenue, S of Elwood Road

26 On Litchfield Road, 1 mile S of U.S. Hwy 80

27 On Cotton Lane, 1 mile S of U.S. Hwy 80

28 Corner of Airport Road and Yuma Road

29 Corner - S of Arlington - Old Gila Bend Road

30 W of Rock Store on north side of Road

SOUTH PHOENIX DISTRICT

1 On S side of Canal - E of 48th St - approximately 10 dumping areas

2 Area behind court located on S side of E Van Buren St at 52nd St (about 20 pickup truck loads)

3 On S side of railroad tracks, 1/4 mi E of 40th St (5 truck loads)

4 On W side of Motorola Plant - fence line (52nd St and Van Buren site) - between Roosevelt St and Culver St (1 truck load scattered around)

5 Between Washington St and the RR tracks and between 52nd St & 56th

6 32nd St, S of the riverbottom (3 or 4 pickup truck loads)

7 16th St, S of the riverbottom (3 or 4 pickup truck loads)

8 7th Ave, S of the riverbottom (3 or 4 pickup truck loads)

9 11th Ave, S of the riverbottom (3 or 4 pickup truck loads)

10 51st Ave and Baseline Road (3 or 4 pickup truck loads)

11 43rd Ave, S of Southern Avenue (1 or 2 car loads)

12 41st Ave, S of Southern Avenue (1 or 2 car loads)

13 24th St and the riverbottom (1 or 2 car loads)

14 Riverbottom, 7th Street, 16th Street, etc

15 43rd Ave and Southern Avenue

16 51st Ave and the riverbottom - both sides of 51st Avenue

17 59th Ave, 0.8 mile south of Buckeye Road

18 35th Ave and the riverbottom

19 7th St and the riverbottom - E of 7th St and S of the riverbottom

20 32nd St and Elwood - just N of overpass across freeway

21 In South Mountain Park (by City) - photos taken 6/6/67

22 Advertising material and service station trash being dumped E of 40th St and S of Baseline Rd along irrigation ditch.

Where there is easy access to the river area from 48th St to 67th Ave, illegal dumping is likely to be found.

ANIMAL FEEDING: Commercial hog feeding on cooked garbage is practiced at 67 rural sites in Maricopa County at this writing. The largest operation had about 700 hogs on feed and received about 10 tons of garbage per week. Garbage for hog feed is collected from separate containers at restaurants, hospitals, schools, hotels, and Williams Air Force Base. Supervision of sanitary practices in garbage cooking for hogs is by by the Arizona State Live Stock Sanitary Board.

INCINERATION: Incineration has been defined as a process in which the combustible fraction of solid wastes is burned in an incinerator plant. There are no municipally owned or operated incinerator plants in Maricopa County. Incineration within the County is limited to on-site operations. On-site means on the site where solid wastes accumulate.

The types of wastes received at each incinerator are characteristic of the classification under which each incinerator is recorded and the premises served.

On-site incinerators may be grouped by classifications of users.

Crematoriums are incinerators used at cemeteries, mortuaries, veterinary hospitals, and humane societies. The special wastes to be burned are human and animal bodies.

Incinerators are used at retirement and nursing homes, medical centers, hospitals, sanitariums, and laboratories. Combustible wastes typical of these places include paper, plastic, cloth, and rubber plus animal tissue and bone. Garbage is burned when it is suspected of being dangerous.

Educational institutions, markets and drugstores, public places plus residences, and private clubs burn paper and garbage principally.

Financial institutions burn paper, principally, as a security matter to prevent release of confidential information.

Industries burn paper, cloth, rubber, plastics, wood, and garbage. Combinations vary from plant to plant.

All incinerators are required by law to be registered with and subject to inspection by the Maricopa County Health Department. Classes and the number of registered incinerators in each class in Maricopa County are listed below; there were 175 of them at the time of tabulation:

Cemeteries and Mortuaries	14
Retirement and Nursing Homes	4
Medical Centers, Hospitals, and Sanitoriums	12
Educational Institutions	48
Financial Institutions	40
Retail Businesses	31
Residences and Private Clubs	13
Pet Crematoriums	4
Public Places	3
Industries	6
Total	175

Complete combustion is achieved in on-site incinerators when the products, ash and gases, are stable and meet air-pollution control standards. Moist organic wastes are the most difficult to burn. The most common failure of on-site incinerators is caused by lack of capacity to burn moist, organic wastes at the rate of charging imposed on them. Frequent failures of on-site incinerators were reported for humane societies and schools.

OTHER DISPOSAL PRACTICES:

Grinding Food Wastes. This process is known to housewives who use grinders below their kitchen sinks to "dispose" of a part of the garbage as it accumulates in the kitchen. The number and location of home garbage disposal units in Maricopa County is not known. The number of units in homes is increasing as indicated by continuing sales. Some businesses (restaurants, e.g.) also use grinders as a preliminary treatment for garbage. No central grinder stations are operated in the County as a process in municipal collection and "disposal" practices.

Grinding and flushing garbage to the sewerage system is a sanitary transportation method. It is limited to the extent that its adoption is voluntary and that it is applicable to a relatively small part of residential solid wastes. Actual disposal of garbage transported via sewers is accomplished at the sewage treatment plant where the increase in organic loading is recognized by its effects on operating practice.

The trend of BOD loading at the sewage treatment plant is believed to be a better indicator for plant design purposes than a count of garbage grinders.

Shredding. Shredding has been defined as a process in which solid wastes are mechanically reduced in particle size as a preliminary step in ultimate disposal. The term usually applies to the use of a stationary plant through which passes wood, rags, paper, garbage, sheet metal, etc. as knives or hammers shred the wastes. No stationary shredding plants are operated by municipalities in Maricopa County.

Brush chippers are used by municipal collection agencies in Maricopa County. These machines differ from stationary shredders in several ways. They are mounted on trucks or trailers and are used at the location where collection is made. The feed is hand selected and fed. Their use is to reduce bulky brush and limbs to less bulky chips. The purpose of the operation is to make the payload more dense during haul for greater efficiency and economy. An added benefit is the volume reduction achieved at the landfill operation.

Rendering. Rendering has been defined as a process in which animal bodies are reduced to useful products. Rendering in Maricopa County is not a municipal process but private business. Public agencies are relieved of a significant problem by the private operation of rendering plants. Private agencies collect, haul, render, and market products. They report no significant amount of solid waste remains as a by-product of rendering.

Dead stock and offal are the principal wastes processed by rendering. Dead stock includes horses, cows, and sheep. Offal includes wastes from slaughterhouses and butcher shops. Quantities processed are not recorded accurately and daily fluctuations are large. By combining reports, an estimate was made that the weight processed on an average day is between 50 and 100 tons in Maricopa County.

Reduction. Reduction has been defined as a process in which garbage is cooked to salvage useful products. This process is not used in Maricopa County. Efficiency of the process decreases as garbage becomes progressively a smaller proportion of the waste with which it is collected. Reduction is not expected to become a useful method of disposal in Maricopa County.

Waste Heat Reclamation. Waste heat reclamation is a process in which heat produced in an incinerator is used for a beneficial purpose. Municipal incinerators are not used in Maricopa County and there is therefore no attempt at waste heat reclamation.

Land Reclamation. Land reclamation is a process in which land surface is raised by landfill to increase its potential uses. This process is in use in Maricopa County.

One example is the park under development by the City of Phoenix west of 19th Avenue and south of Greenway Road. An interim use is an equipment yard for parking of collection equipment. The City of Glendale has developed a series of sites from eroded places of no economic value into leveled, agricultural land.

Land reclamation is a key factor in a continuing landfill program. It is generally true that a proposed landfill site induces a negative reaction by owners of land surrounding the site. The history of dumps is the cause of the stigma attached to the term. That reaction is predictable and logical.

Specific objections are usually made to two nuisances: (1) a proposed concentration of garbage trucks, flat beds, trailers, and pick-ups hauling enclosed or exposed loads of waste, and (2) the dump, itself. The objector does not distinguish between the terms "dump," "landfill," and "sanitary landfill." In Maricopa County there are many examples of dumps and landfills where land reclamation is not a part of a funded, positive plan.

Many planning reports (including land use maps) have been reviewed. None of those for areas within Maricopa County have indicated consideration of waste disposal facilities. The only sites reported to have been planned and completed are the agricultural sites near Glendale.

Land reclamation is a key factor in landfill programs and has been generally neglected in Maricopa County landfill programs.

Dehydration. Dehydration is a process in which moisture is removed from garbage in preparation for temporary storage. Salvage of garbage is not practiced in Maricopa County. Dehydration is therefore not practiced.

Salvage. Salvage has been defined as a process in which some useful fraction is separated from useless solid wastes and marketed. Only significant amounts of salvage are of concern in this study. Therefore, the marketing of salvage is the purpose, and profit is the motive. Economics is the control in determining what may be "useful" or "useless."

Methods of separation include hand picking, magnetic separation from piles of wastes, magnetic separation on conveyor belts, separate collections on-site, intermediate sizing as by screening, and burning.

Most of the former markets for salvage have disappeared as a result of the increasing labor and transportation costs required in the process. (For a more complete discussion of salvage practices and history, the reader is referred to Chapter 10, Page 316 of Municipal Refuse Disposal prepared by the American Public Works Association.)

Significant salvage markets in Maricopa County include "tin" cans, cardboard, car bodies, and paper. Some Arizona copper mining firms use the leaching method to recover copper from low grade ore, precipitating copper from solution by passing the solution over "tin" cans. The demand for cans varies with the price for copper because the leaching processes are expanded during higher price periods and curtailed as prices wane. Thus the volume demand and price for salvaged cans varies beyond much influence by the salvager.

The market for paper and corrugated cardboard is even more variable. The volume of paper collected is unknown but is obviously a large and increasing proportion of wastes collected. One paper salvage firm reported a maximum month's collection of salvageable paper and corrugated cardboard to be an amount equal to an average day of wastes collection in the City of Phoenix. That indicates salvaged paper may amount to as much as 3 percent or as little as zero percent of the total wastes collected depending upon the current market.

Composting: History of municipal composting plants in Maricopa County includes two operations, one experimental plant at Chandler and one commercial plant at Phoenix. Small scale composting of agricultural wastes has probably been practiced in the County but no records of them have been found. A summary of the Phoenix plant operations is included in Section 2 beginning on Page S 2-29.

The Chandler composting experience is reported in "Municipal Refuse Disposal," American Public Works Association, as being one of two composting research projects. The second was at Savannah, Georgia. These projects began in 1953 under the direction of the United State Public Health Service. Aeration, bin, and windrow composting was done on an experimental basis in a plant rated at 70 tons per week capacity near Chandler. No full-scale composting operation was developed in Maricopa County as a result of the experimental operation at Chandler. The City of Chandler did not report on this project during this study.

DISPOSAL RECORDS: Records of quantities of solid wastes disposed of by some municipal and private facilities in Maricopa County have been made available. These records, based on either measurements or estimates, have been listed and extended in tables. Some of these records have been arranged in graphs. These tables and graphs, numbered with an "R" prefix to indicate "records," are sequentially included herein (Pages S 4-24 through S 4-47) as:

R-T1 (Page S4-24) is a table that lists measured weights by months for solid wastes received at the three (combined) Phoenix landfills during fiscal year 1967. R-P1 (Page S 4-25) is a graph of this table's values.

R-T2 (Page S 4-26) is a table that lists measured weights of the maximum daily amounts for solid wastes received at the three (combined) Phoenix landfills for each month during fiscal year 1967. R-P2 (Page S 4-27) is a graph of this table's values.

R-T3 (Page S 4-28) is a table that lists measured weights of the maximum daily amounts for solid wastes, classified as to "trash," "garbage," or "miscellaneous," as to haul agency, and as to percent of tonnage by haul agency, received at the Phoenix 15th Avenue landfill for each month during fiscal year 1967.

R-T4 (Page S 4-29) is a table that lists similar values for the Phoenix 19th Avenue landfill for the same period and in the same format as Table R-T3.

R-T5 (Page S 4-30) is a table that lists measured weights of the maximum daily amounts for solid wastes, classified as to "trash," "garbage," or "miscellaneous," received at the Phoenix 16th Street landfill for each month during fiscal year 1967.

R-P3 (Page S 4-31) is a graph indicating the measured weights of the solid wastes received at the three (combined) Phoenix landfills, expressed as maximum daily amounts per month and as cumulative amounts, during fiscal year 1967.

R-T6 (Page S 4-32) is a table that lists factors for measured solid waste weights received at the individual and combined Phoenix landfills during fiscal year 1967.

R-T7 (Page S 4-33) is a table that lists measured weights of the solid wastes hauled by various agencies to the individual and combined Phoenix landfills during fiscal year 1967. R-P4 (Page S 4-34) is a graph of this table's values.

R-T8 (Page S 4-35) is a table that lists measured weights by months and calculations of factors for solutions and slurries received at the individual and combined Phoenix landfills during the period between July 1965 and April 1967. R-P5 (Page S 4-36) is a graph and further listing of factors for this table.

R-P6 (Page S 4-37) is a graph that summarizes measured weights by months and calculated factors for solid wastes, classified as to city or non-city haul, received at the combined Phoenix landfills during the period between July 1965 and April 1967.

R-T9 (Page S 4-38) is a table that lists estimated volumes of solid wastes by months, classified by source, received at the Tri-Community landfill during the period between April 1966 and July 1967. Table R-T9 also contains the derivation of factors for this solid waste loading. R-P7 (Page S 4-39) is a graph of this table's listed values.

R-T10 (Page S 4-40) is a table that lists measured load counts and calculations of weights of solid wastes by month hauled by the City of Chandler and received at the Chandler-Gilbert-County landfill during the period between July 1965 and March 1967. R-P8 (Page S 4-41) is a graph of this table's listed values.

R-T11 (Page S 4-42) is a table that lists estimated volume and calculations of weights of solid wastes received at the Glendale Landfill No. 5, classified as to source, during the period between August 1966 and July 1967.

R-T12 (Page S 4-43) is a table that lists estimated and calculated volumes and related factors for solid wastes received at all Glendale landfills during the period between November 1961 and July 1967. R-P9 (Page S 4-44) is a cumulative graph and further listing of factors for this table.

R-T13 (Page S 4-45) is a table that lists estimated counts and weights and disposal details concerning dead animals in the metropolitan county area.

R-T14 (Page S 4-46) is a table that lists estimated volumes and weights by months and calculated factors for solid wastes, classified as to method of haul, received at the Tempe landfill during calendar year 1967. R-P10 (Page S 4-47) is a graph of this table's values.

Table R-T1

MONTHLY SOLID WASTES TONNAGE
TO CITY OF PHOENIX LANDFILLS

Month (1)	15th Ave (2)	16th St (3)	19th Ave (4)	Total (5)
1966				
Jun	17,224	7,807	11,995	37,026
Jul	17,025	7,195	13,215	37,435
Aug	19,379	8,099	14,386	41,864
Sep	17,733	8,590	14,089	40,412
Oct	18,848	8,053	14,272	41,173
Nov	18,090	7,282	13,208	38,580
Dec	18,538	7,688	13,599	39,825
1967				
Jan	18,787	7,667	14,350	40,804
Feb	17,439	7,038	12,795	37,272
Mar	21,309	8,662	14,400	44,371
Apr	19,287	7,664	13,780	40,731
May	20,662	8,580	14,194	43,436
Totals	224,321	94,325	164,283	482,929
Avg Days	615	258	450	1,323

Maximum monthly tonnage during year is underscored for each landfill and the total

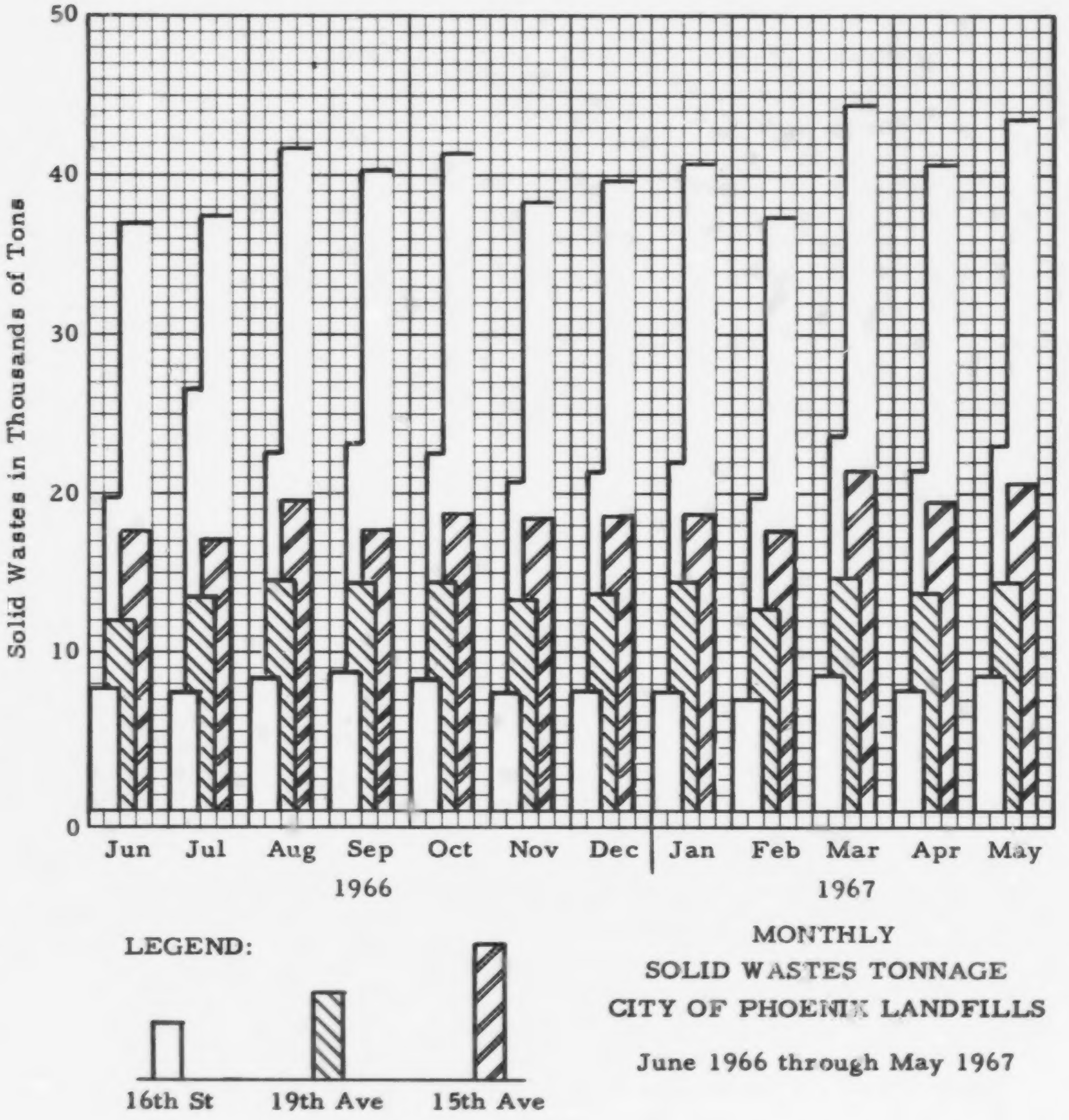
Source: Sanitation Department, City of Phoenix

Plate R-P1

The maximum tonnage at each landfill occurred in March:

	Tons	Percent
16th Street Landfill	8, 662	20
19th Avenue Landfill	14, 400	32
15th Avenue Landfill	21, 309	48
Total	44, 371	100

Factors:		
	Average Month	40, 244 tons
	Maximum Month	44, 371 tons, or 110% of average month
	Minimum Month	37, 026 tons, or 92% of average month



MONTHLY
SOLID WASTES TONNAGE
CITY OF PHOENIX LANDFILLS

June 1966 through May 1967

Table R-T2

MAXIMUM DAILY SOLID WASTES TONNAGE
THREE PHOENIX LANDFILLS, COMBINED

Maximum Day of Month	
(1) Month	(2) Tons
1966	
Jun	1,814
Jul	1,852
Aug	2,031
Sep 28	2,136*
Oct	1,965
Nov	1,832
Dec	1,964
1967	
Jan	1,934
Feb	1,843
Mar	1,944
Apr	2,060
May	1,997

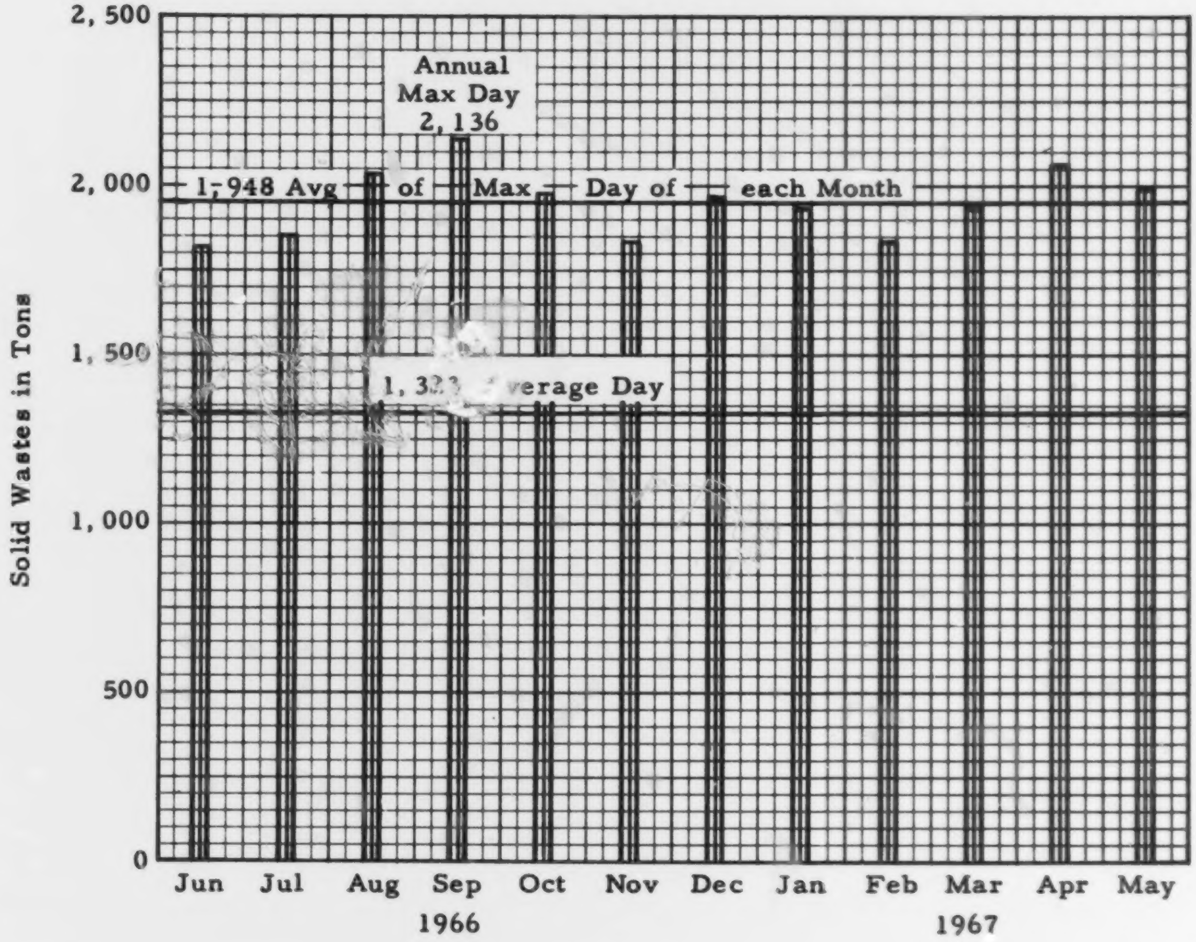
---

* Maximum day of 12 months

Plate R-P2

SOLID WASTES FACTORS:

Annual average day	1, 323 tons
Annual maximum day	2, 136 tons
Maximum day is 161% of average day	
Average of maximum days for each month	1, 948 tons
Least of maximum days for each month	1, 814 tons
Variation from average of maximum days: +10%, -7%	



DAILY
SOLID WASTES TONNAGE
CITY OF PHOENIX LANDFILLS

June 1966 through May 1967

Table R-T3

MAXIMUM DAILY SOLID WASTES TONNAGE

PHOENIX LANDFILL, 15TH AVENUE AND SALT RIVER

	PHOENIX* Max. Day of Month				OTHERS* Maximum Day of Month						TOTALS*		% OF LAND-FILL	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
					Private Firms									
Month	Trash	Garbage	Misc	Total	A	B	C	Cash or Credit	Yearly License	Free Vehicles	Landfill	Phoenix**	Phoenix	Others
1966														
Jun	94	183	56	304	–	149	88	293	229	3	1,018	294	29	71
Jul	144	204	143	395	–	124	103	161	250	136	878	273	31	69
Aug	66	207	103	352	17	155	132	268	320	119	1,045	257	25	75
Sep	95	235	50	335	22	86	104	181	305	89	905	324	36	64
Oct	123	214	100	384	17	85	98	134	229	117	917	384	42	58
Nov	103	207	85	328	28	113	100	126	209	95	857	328	38	62
Dec	88	222	82	372	18	124	118	223	176	96	915	218	24	76
1967														
Jan	82	212	73	326	23	115	100	264	197	106	976	307	31	69
Feb	86	205	55	313	23	140	209	249	215	121	891	214	24	76
Mar	94	231	51	326	20	131	116	153	219	138	954	326	34	66
Apr	68	242	69	338	34	121	110	164	215	140	940	284	30	70
May	65	243	59	217	15	384	330	133	214	125	1,143	212	19	81

Source: Sanitation Department, City of Phoenix

Maximum daily tonnage for 12 months is underscored in each category

* Entries in Cols (2) through (12) are not necessarily for the same day

** Tons by Phoenix on total maximum day to landfill

Table R-T4

MAXIMUM DAILY SOLID WASTES TONNAGE
PHOENIX LANDFILL, 19TH AVENUE

	PHOENIX* Max. Day of Month				OTHERS* Maximum Day of Month						TOTALS*		% OF LAND-FILL	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
					Private Firms									
Month	Trash	Garbage	Misc	Total	A	B	C	Cash or Credit	Yearly License	Free Vehicles	Landfill	Phoenix**	Phoenix	Others
1966														
Jun	120	242	72	378	30	32	22	164	62	3	596	378	63	37
Jul	89	288	188	464	37	67	21	197	82	192	687	412	60	40
Aug	57	336	158	469	24	52	20	374	36	70	841	344	41	59
Sep	112	340	192	547	37	45	17	220	42	82	729	453	62	38
Oct	184	305	56	451	24	56	40	186	68	104	740	396	54	46
Nov	113	294	77	415	37	33	25	139	83	86	692	395	57	43
Dec	94	374	48	468	29	29	22	134	77	62	690	468	68	32
1967														
Jan	116	303	85	430	25	22	18	107	80	64	660	408	62	38
Feb	116	261	60	407	20	17	18	115	99	76	674	404	60	40
Mar	109	294	34	407	20	18	14	120	102	95	674	407	60	40
Apr	80	345	56	455	24	40	55	208	106	111	765	455	59	41
May	71	355	119	437	35	42	40	234	79	91	742	389	52	48

Source: Sanitation Department, City of Phoenix

Maximum daily tonnage for 12 months is underscored in each category

* Entries in Cols (2) through (12) are not necessarily for the same day

** Tons by Phoenix on total maximum day to landfill

Table R-T5

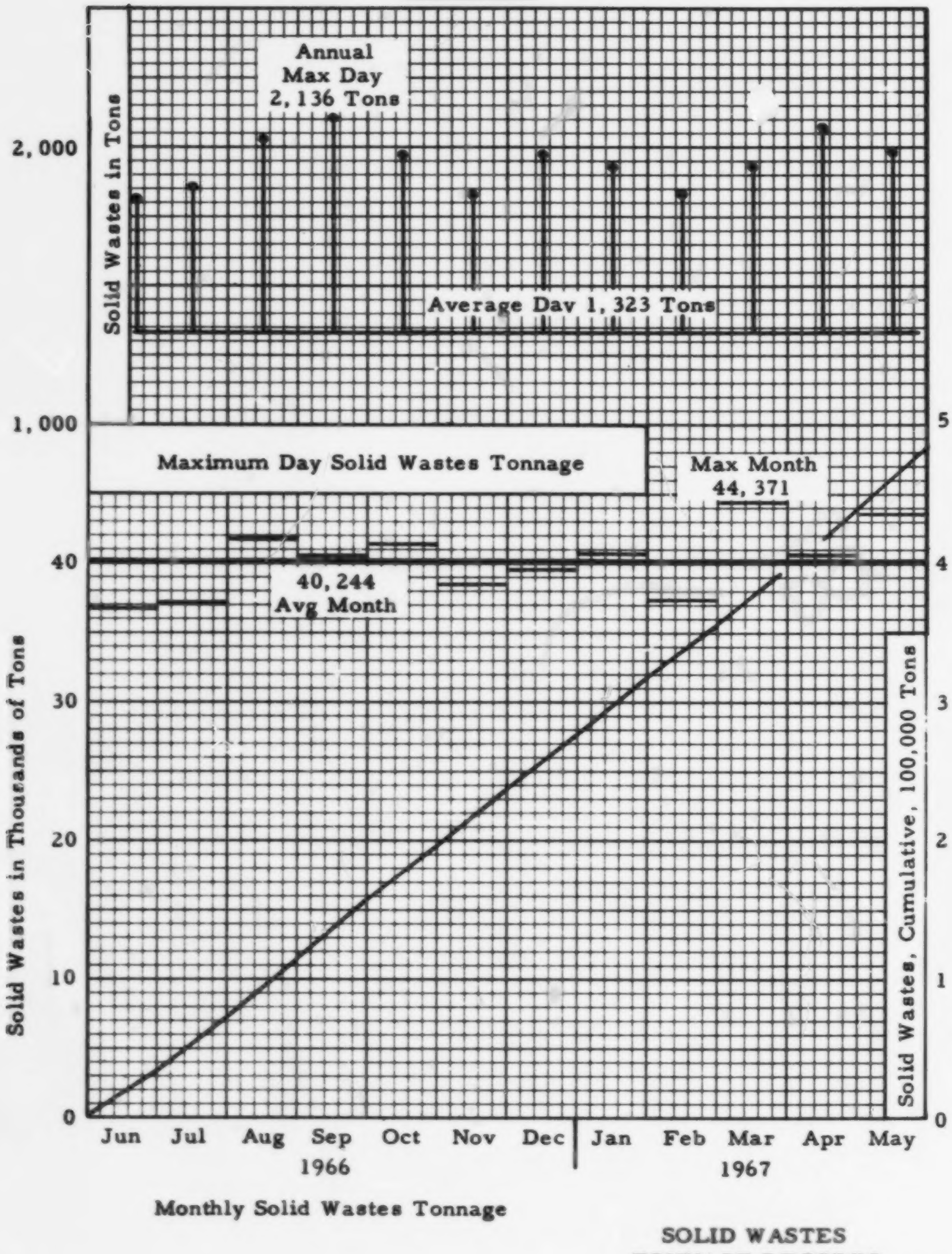
MAXIMUM DAILY SOLID WASTES TONNAGE

PHOENIX LANDFILL, 16TH STREET AND SALT RIVER

	PHOENIX*			
	Maximum Day of Month			
(1) Month	(2) Trash	(3) Garbage	(4) Miscellaneous	(5) Total
1966				
Jun	131	213	84	375
Jul	112	242	42	360
Aug	111	287	65	415
Sep	121	295	117	503
Oct	118	255	97	376
Nov	115	268	60	395
Dec	115	270	35	373
1967				
Jan	109	244	122	375
Feb	101	258	98	423
Mar	127	311	95	373
Apr	90	297	108	399
May	96	301	214	548

Source: Sanitation Department, City of Phoenix
Maximum daily tonnage for 12 months is underscored in each category
* Entries in Cols (2) through (5) are not necessarily for the same day

Plate R-P3



SOLID WASTES
TONNAGE RECORDS
THREE PHOENIX LANDFILLS

June 1966 through May 1967

Table R-T6

FACTORS DEVELOPED FROM
PHOENIX DAILY RECORDS OF TONNAGE TO LANDFILLS

(1) By combining data for 3 landfills: (June 1966 - May 1967)

Annual Average Day	1,323 Tons
Annual Total	482,929 Tons
Maximum Day	2,136 Tons
Ratio, Max Day : Avg Day	161 %

(Estimated average population contributing: 518,000)

Per Capita Annual Total	0.93 Ton
Per Capita Average Day	5.1 Lbs
Per Capita Maximum Day	8.3 Lbs

(2) 16th Street Landfill Data: (June 1966 - May 1967)

Annual Average Day	258 Tons
Annual Total	94,325 Tons
Maximum Day	548 Tons
Ratio, Max Day : Avg Day	210 %

(3) 15th Avenue Landfill Data: (June 1966 - May 1967)

Annual Average Day	615 Tons
Annual Total	224,321 Tons
Maximum Day	1,143 Tons
Ratio, Max Day : Avg Day	186 %

(4) 19th Avenue Landfill Data: (June 1966 - May 1967)

Annual Average Day	450 Tons
Annual Total	164,283 Tons
Maximum Day	841 Tons
Ratio, Max Day : Avg Day	187 %

Table R-T7

SOLID WASTES HAULED TO CITY OF PHOENIX LANDFILLS

BY MONTHS

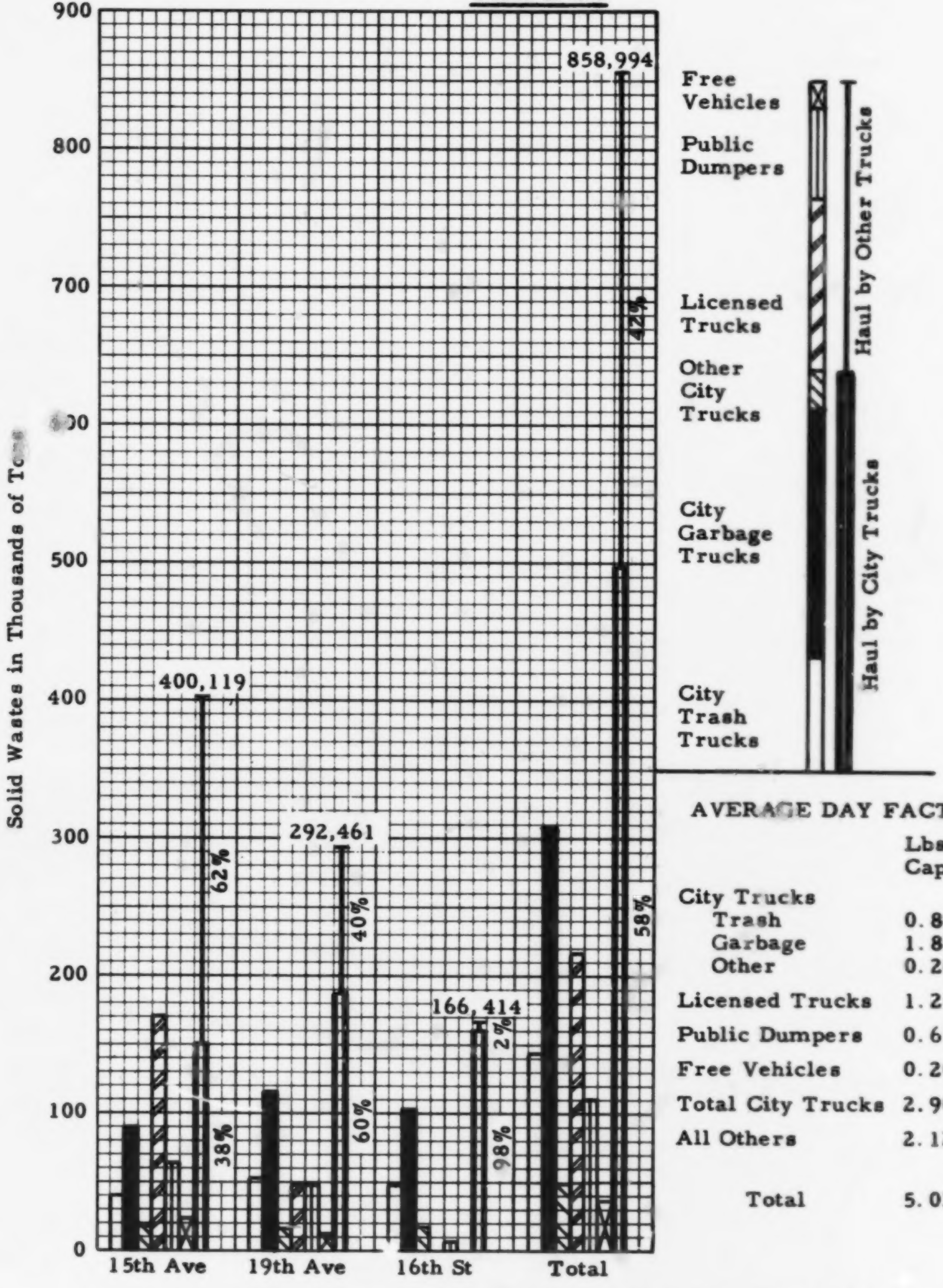
July 1965 through April 1967

Weights in Tons

	City Trucks								
Month (1)	Trash (2)	Garbage (3)	Other (4)	City Total (5)	Licensed Dumpers (6)	Public Dumpers (7)	Free Vehicles (8)	Non-City Total (9)	Total (10)
1965 Jul	7,764	13,817	1,221	22,802	7,409	4,785	90	12,284	35,086
Aug	7,795	12,729	1,449	21,973	6,868	6,959	33	13,860	35,833
Sep	7,862	12,179	1,118	21,159	6,910	6,440	70	13,420	34,579
Oct	7,643	12,217	1,024	20,884	7,173	7,667	43	14,883	35,767
Nov	8,276	13,123	1,406	22,805	7,787	6,295	27	14,109	36,914
Dec	8,753	14,699	2,519	25,971	8,735	4,956	15	13,706	39,677
1966 Jan	9,054	12,612	1,667	23,333	9,892	6,090	47	16,029	39,362
Feb	6,589	11,366	2,746	20,701	9,808	5,449	55	15,312	36,013
Mar	8,702	13,363	2,798	24,863	11,108	6,175	49	17,332	42,195
Apr	7,944	12,778	2,462	23,184	10,805	6,198	376	17,379	40,563
May	6,908	12,616	3,263	22,787	9,526	5,167	60	14,753	37,540
Jun	6,296	13,090	2,123	21,509	9,408	6,091	18	15,517	37,026
Jul	4,234	14,865	2,919	22,018	8,824	3,619	2,924	15,367	37,385
Aug	3,719	16,723	2,837	23,279	9,912	5,354	3,316	18,582	41,861
Sep	4,767	16,167	2,667	23,601	8,956	4,102	2,979	16,037	39,638
Oct	6,929	14,679	1,868	23,476	10,458	3,445	3,650	17,553	41,029
Nov	4,918	14,826	1,626	21,370	10,840	3,186	3,072	17,098	38,468
Dec	5,202	15,375	1,592	22,169	10,808	3,870	2,921	17,599	39,768
1967 Jan	5,346	15,124	2,253	22,723	11,042	3,886	3,102	18,030	40,753
Feb	4,995	13,671	1,734	20,400	10,054	3,565	3,097	16,716	37,116
Mar	5,436	16,649	1,962	24,047	12,292	4,006	3,916	20,214	44,261
Apr	3,904	15,768	1,726	21,398	10,936	4,037	4,365	19,338	40,736
a) Total	143,036	308,436	44,980	496,452	209,551	111,342	34,225	355,118	851,570
b) Annual Avg	78,024	168,240	24,540	270,804	114,300	60,732	18,672	193,704	464,496
c) Monthly Avg	6,502	14,020	2,045	22,567	9,525	5,061	1,556	16,142	38,708
d) Daily Avg	213.8	460.9	67.2	741.9	313.1	166.4	51.2	530.7	1272.6
e) Lbs/cap/day*	0.84	1.80	0.26	2.90	1.22	0.65	0.20	2.07	4.97

Maximum monthly tonnage is underscored for each category.
Source: Sanitation Department, City of Phoenix.
* Average population this time period, 511,000.

Plate R-P4



AVERAGE DAY FACTORS

	Lbs/ Cap.	%
City Trucks		
Trash	0.84	17
Garbage	1.80	36
Other	0.26	5
Licensed Trucks	1.28	25
Public Dumpers	0.65	13
Free Vehicles	0.20	4
Total City Trucks	2.90	58
All Others	2.12	42
Total	5.03	100

SOLID WASTES HAULED BY VARIOUS AGENCIES TO
CITY OF PHOENIX LANDFILLS
July 1965 through April 1967

Table R-T8

LIQUID SOLUTIONS AND SLURRIES TO PHOENIX LANDFILLS

July 1965 through April 1967

Month	15th Ave	19th Ave	Total
1965			
Jul	1,695	522	2,217
Aug	1,401	402	1,803
Sep	1,401	492	1,893
Oct	1,484	441	1,925
Nov	1,776	543	2,319
Dec	1,782	693	2,475
1966			
Jan	2,099	1,092	3,191
Feb	1,752	726	2,478
Mar	1,616	725	2,341
Apr	1,591	600	2,191
May	1,365	643	2,008
Jun	1,200	527	1,727
Jul	1,219	533	1,752
Aug	1,145	618	1,763
Sep	1,062	578	1,640
Oct	1,339	507	1,846
Nov	1,472	733	2,205
Dec	1,761	789	2,550
1967			
Jan	1,588	772	2,360
Feb	1,325	683	2,008
Mar	1,674	812	2,486
Apr	1,215	683	1,898
Total	32,962	14,114	47,076
Monthly Average	1,498	642	2,140
Yearly Average	17,976	7,704	25,680
Daily Average	49.2	21.1	70.3
Lbs/Day Avg	98,400	42,200	140,600
Lbs/Cap/Day	0.19	0.08	0.27

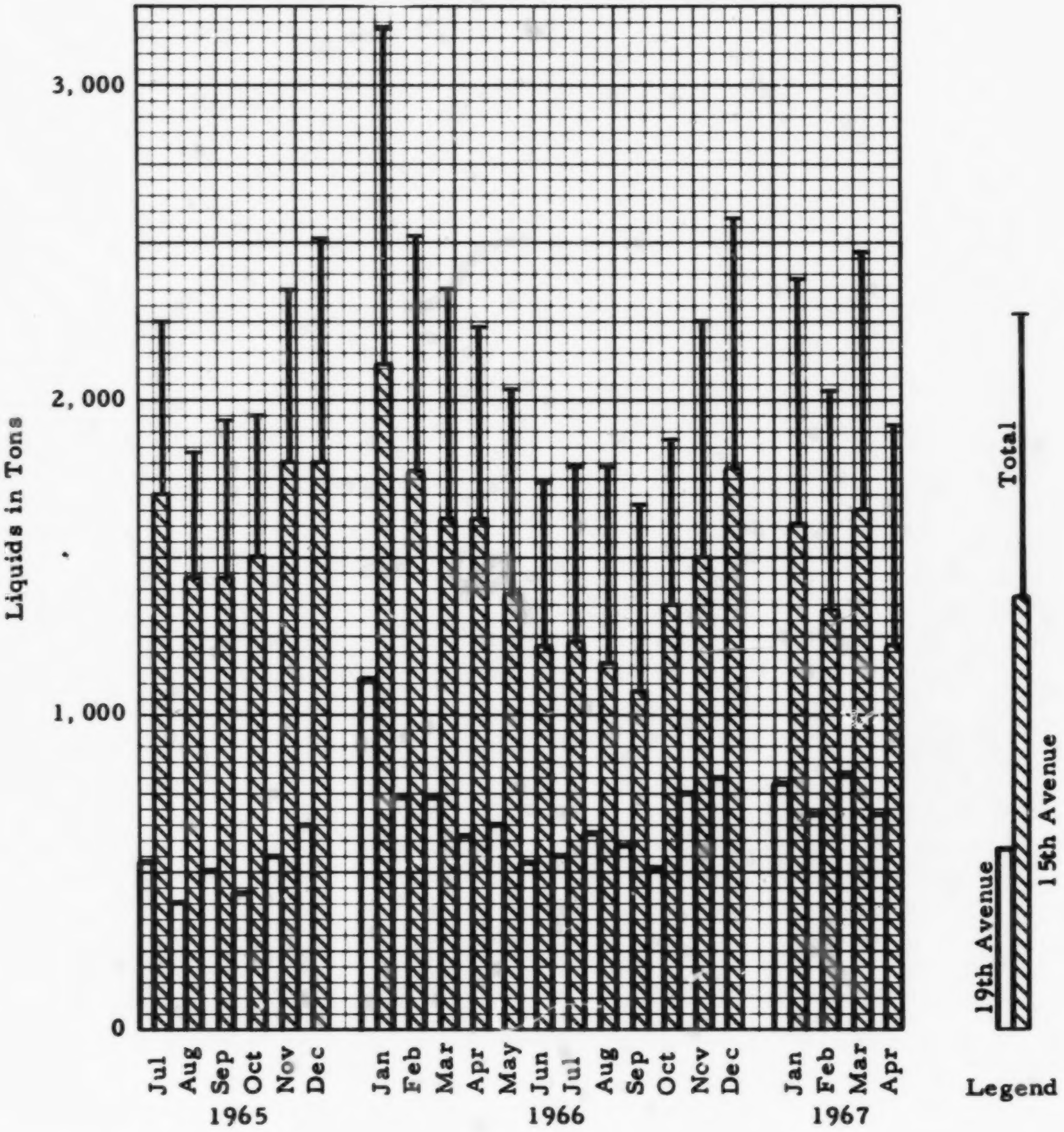
Maximum monthly tonnage is underscored for each landfill & the total.
Average population is 511,000.
Tank trucks delivered cesspool and industrial wastes.
Industrial wastes included acids, caustics, lime, oil, grease, & others.
Source: Sanitation Department, City of Phoenix

Plate R-P5

Maximum Tonnage at each Landfill occurred in Jan. 1966

19th Ave Landfill	1,092 Tons	34%
15th Ave Landfill	2,099 Tons	66%
16th St Landfill	0	0
Total	3,191 Tons	100%

Factors:	Avg Month	2,139 Tons
	Max Month	3,191 Tons or 150% of Avg Month
	Min Month	1,640 Tons or 77% of Avg Month



LIQUIDS TO PHOENIX LANDFILLS
(Solutions and Slurries)

July 1965 through April 1967

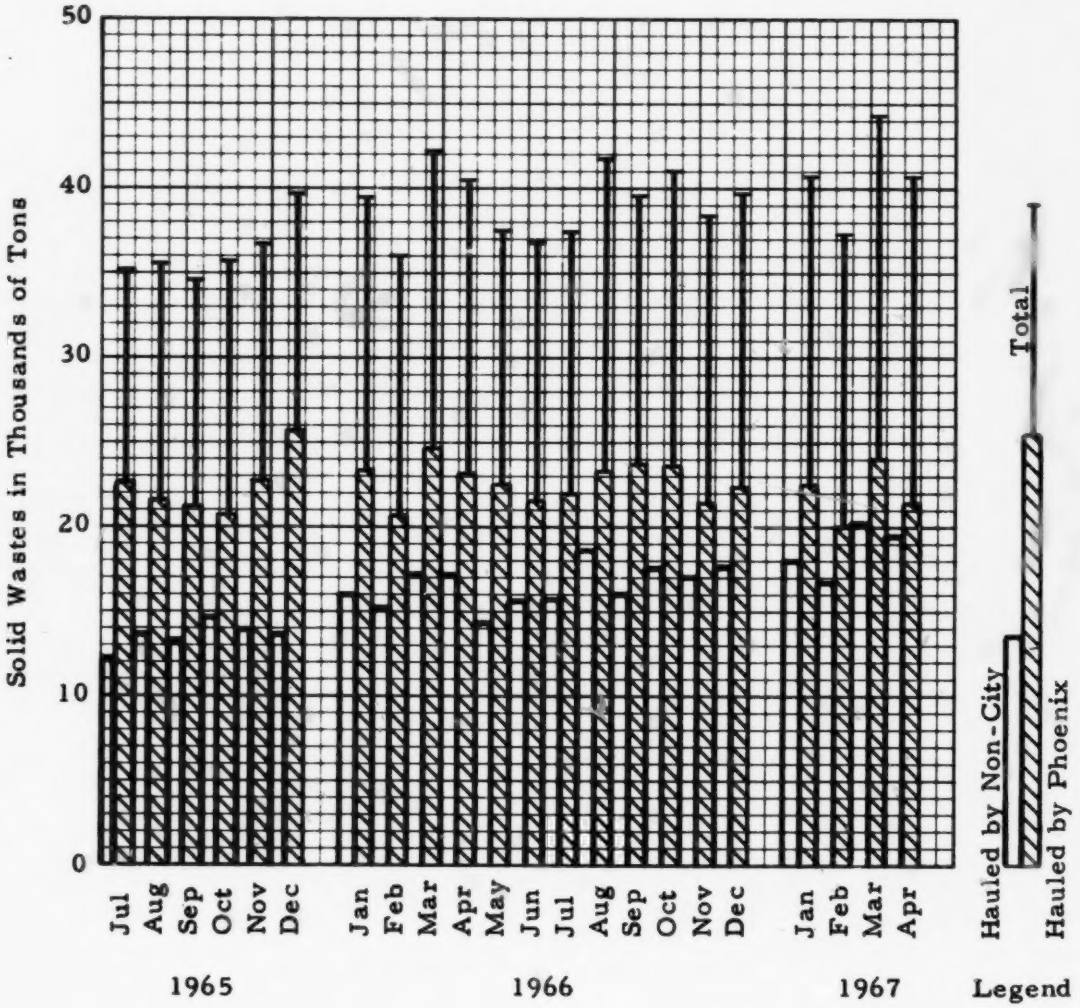
Plate R-P6

Maximum Monthly Total, March 1967:

Hauled by City of Phoenix Trucks	24,047 Tons	54%
Hauled by Non-City Trucks	20,214 Tons	46%
Total	44,261 Tons	100%

Maximum & Minimum Months as Percent of Average Month:

	Phoenix		Non-City		Total	
	Tons	%	Tons	%	Tons	%
Max Month	25,971	115	20,214	13	44,261	114
Avg Month	22,567	100	16,142	100	38,708	100
Min Month	20,400	91	12,284	76	34,579	89



SOLID WASTES HAULED TO CITY OF PHOENIX LANDFILLS

BY MONTHS

July 1965 through April 1967

Table R-T9

MONTHLY SOLID WASTES VOLUME TO TRI-COMMUNITY LANDFILL

OPERATED BY SALT RIVER MARICOPA-PIMA INDIAN COMMUNITY

(Includes Mesa and Scottsdale)

April 1966 through July 1967

Month		Mesa		Scottsdale		Others		Total	
		Cu Yds	%	Cu Yds	%	Cu Yds	%	Cu Yds	%
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1966	Apr (Part)*	9,419	45	8,980	43	2,457	12	20,856	
	May	13,407	45	12,243	41	4,102	14	29,752	
	June	13,946	47	12,285	42	3,336	11	29,567	
	July	12,920	47	11,430	42	3,180	11	27,530	
	Aug	13,769	46	12,852	43	3,519	11	30,140	
	Sep	14,512	49	11,661	39	3,580	12	29,753	
	Oct	13,718	45	13,264	43	3,764	12	30,746	
	Nov	14,727	47	13,688	43	3,272	10	31,687	
	Dec	15,634	48	14,278	43	3,017	9	32,929	
1967	Jan	15,418	48	14,065	43	2,802	9	32,285	
	Feb	15,501	49	13,708	43	2,687	8	31,896	
	Mar	15,443	45	15,685	46	3,209	9	34,337	
	Apr	12,884	42	14,075	46	3,757	12	30,716	
	May	14,065	43	15,121	47	3,251	10	32,437	
	June	12,486	41	14,416	48	3,209	11	30,111	
	July	11,689	41	13,846	49	3,009	10	28,544	
	Totals	219,538	45	211,597	44	52,151	11	483,286	
Factors									
Min Whole Month		11,689		11,430		2,687		27,530	
Maximum Month		15,634		15,685		4,102		34,337	
Average Month		13,980		13,480		3,320		30,780	
Variation from Average Month									
Maximum Month +		1,654	12	2,205	16	782	24	3,557	12
Minimum Month -		2,291	16	2,050	15	633	19	3,250	11
Haul by Cities									
Cu Yds/Capita/Year		3.2		2.8					
Population		53,176**		58,350**		(Not available)			

Estimated Weight of Annual Solid Wastes

Estimated Density in Trucks:
Mesa: 60% Compactors, 40% Open
Scottsdale: 100% Compactors

Compactors 480 lbs/cu yd x 0.6 = 290
Open (Mesa) 200 lbs/cu yd x 0.4 = 80
Weighted Average (Mesa) 370

	Mesa	Scottsdale	Others	Total
Annual Total (Tons)	31,000	39,000	9,600	79,600
Average Day (Tons)	85	108	26	219
Haul by Cities Lbs/Capita/Avg Day	3.2	3.8		

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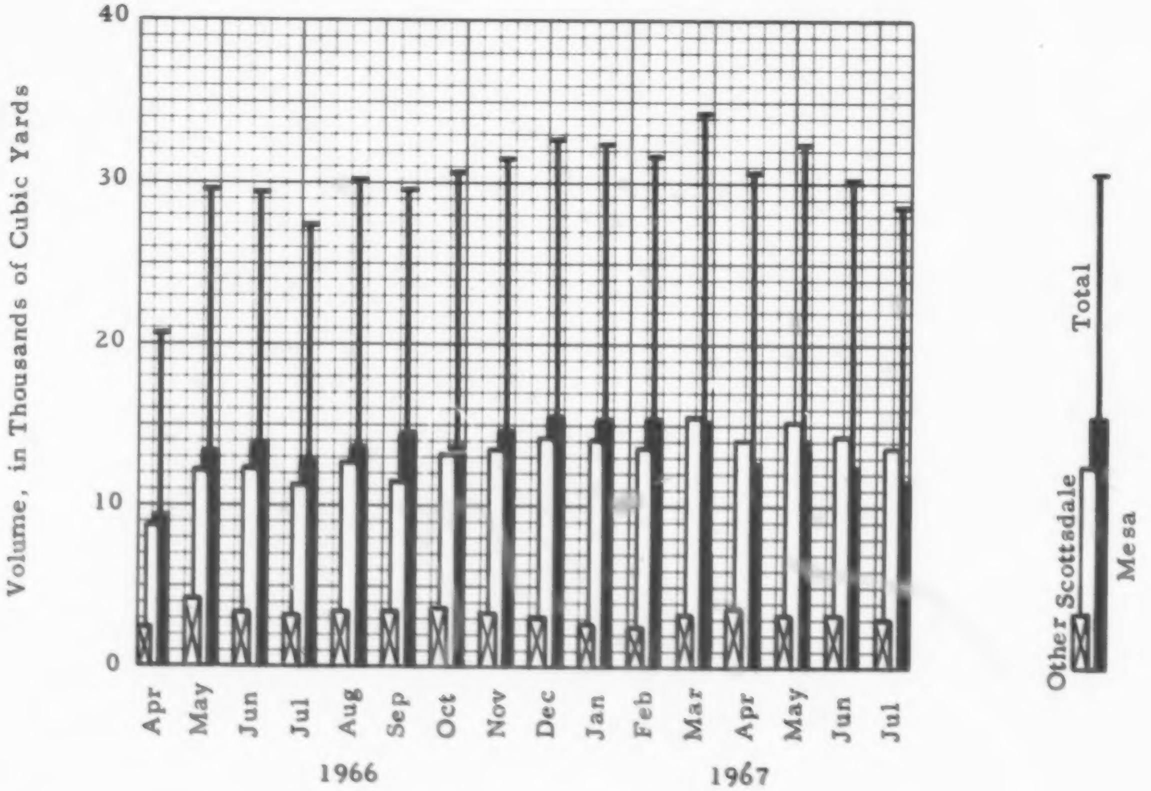
*Operations begun April 9, 1966. Total of 15.7 months.
** Self-estimate by city.

Plate R-P7

FACTORS:

	Minimum Month			Avg Mo CY	Maximum Month			Estimated Contributing
	Diff %	Diff CY	CY		CY	Diff CY	Diff %	
Mesa	16	2,291	11,689	13,980	15,634	1,654	12	53,176
Scottsdale	15	2,050	11,430	13,480	15,685	2,205	16	58,350
Others	19	633	2,687	3,320	4,102	782	24	Unknown
Total	11	3,250	27,530	30,780	34,337	3,557	12	Unknown

Note: Landfill operations began April 9, 1966.



MONTHLY SOLID WASTES VOLUME TO

TRI-COMMUNITY LANDFILL

(Includes: Indian Community, Mesa, Scottsdale, and part of Maricopa County)

Table R-T10

MONTHLY SOLID WASTES DATA

CITY OF CHANDLER

	Collection				Landfill			
	Record		Calculation		Record		Calculation	
Month	Brush (Loads)	Garbage (Loads)	Total (Loads)	% of Avg H or L	Brush (Tons)	Garbage (Tons)	Total (Tons)	% of Avg H or L
1965								
Jul	121	152^{L}	273	89	214	520	734	
Aug	143	179	322		254	582	836	
Sep	123	166	289		213	450	663^{L}	85
Oct	154	183	337		273	557	830	
Nov	129	165	294		229	456	685	
Dec	131	199	330		195	680^{H}	875	133
	(801)	(1,044)	(1,845)		(1,378)	(3,245)	(4,623)	
1966								
Jan	179	163	342		318	646	964^{H}	123
Feb	99	171	270^{L}	84	176	513	689	
Mar	129	186	315		229	604	833	
Apr	130	182	312		231	515	746	
May	98^{L}	188	286	71	175^{L}	511	686	64
Jun	117	173	290		243	544	787	
	(752)	(1,063)	(1,815)		(1,372)	(3,333)	(4,705)	
Jul	154	186	340		321	438	759	
Aug	174	174	348		331	433	764	
Sep	129	169	298		334	434	768	
Oct	183	170	353		293	492	785	
Nov	191^{H}	170	361	137	283	503	786	
Dec	161	204	365		368	556	924	
	(992)	(1,073)	(2,065)		(1,930)	(2,856)	(4,786)	
1967								
Jan	186	206^{H}	392^{H}	121/121	425^{H}	406^{L}	831	155/80
Feb	172	165	337		331	422	753	
Mar	157	179	336		325	455	780	
Total	3,060	3,730	6,790		5,761	10,717	16,478	
Avg	146	178	323		274	510	785	

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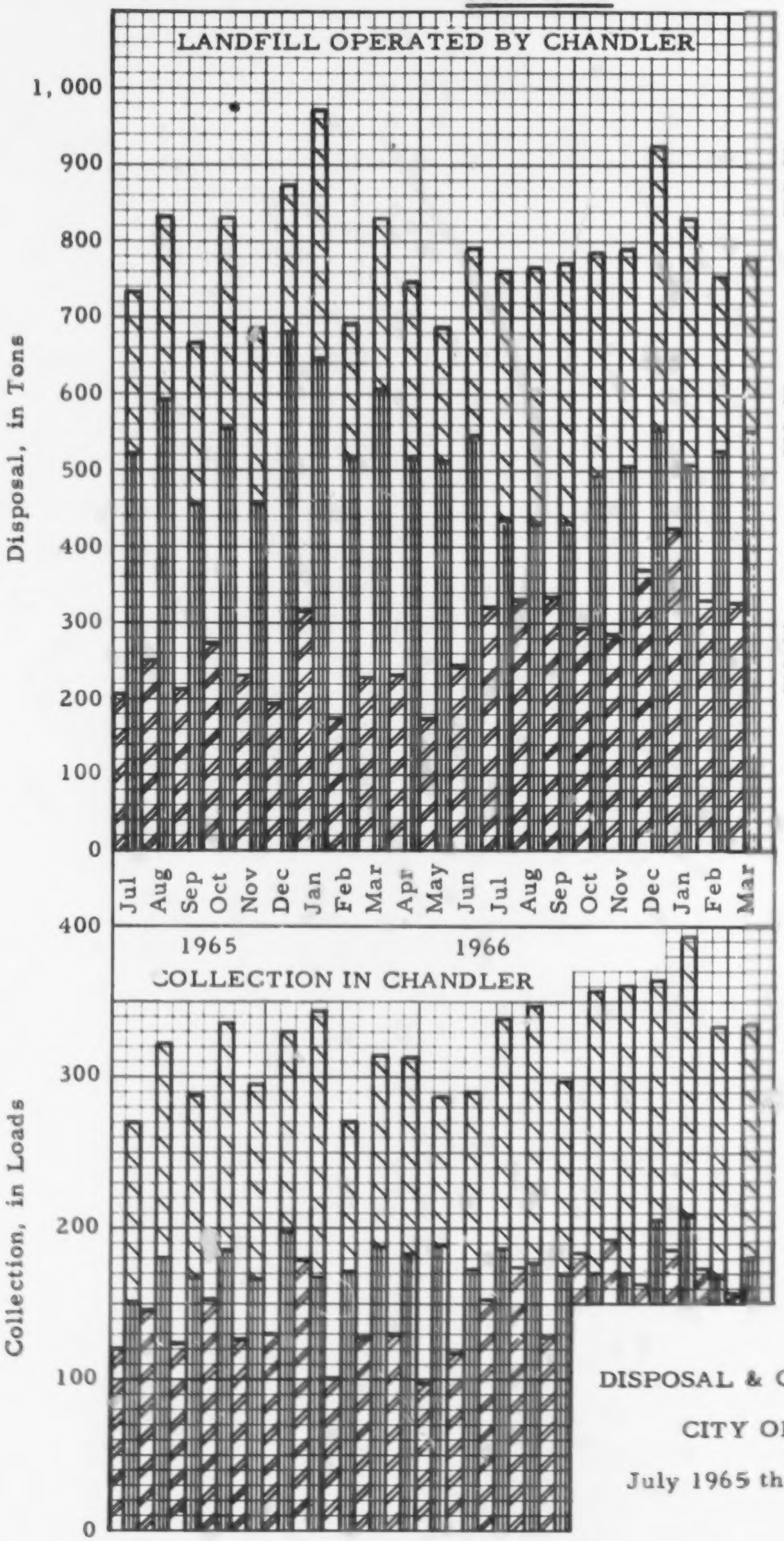
^{H} Indicates high month in category

^{L} Indicates low month in category

( ) Indicates 6-month subtotal

Plate R-P8



TOTAL SOLID WASTES

Max Month	964 Tons
Avg Month	785 Tons
Min Month	663 Tons

Max = 123% of Avg
Min = 85% of Avg

GARBAGE

Max Month	680 Tons
Avg Month	510 Tons
Min Month	406 Tons

Max = 133% of Avg
Min = 80% of Avg

BRUSH

Max Month	425 Tons
Avg Month	274 Tons
Min Month	175 Tons

Max = 155% of Avg
Min = 64% of Avg

DISPOSAL & COLLECTION DATA

CITY OF CHANDLER

July 1965 through March 1967

Table R-T11

GLENDALE LANDFILL NO. 5 DATA

August 1, 1966 through July 1, 1967

Estimated Monthly Data*			Calculated**		Estimated**			
Solid Wastes			Volume in CY		Average Day			
Source (1)	Kind (2)	Vol (CY) (3)	Annual (4)	Avg Day (5)	Lbs/ CY (6)	Lbs (7)	Tons (8)	% (9)
Glendale	Garbage	7,660	91,920	255	380	97,000	49	50.0
Glendale	Trash	900	10,800	30	Not available			
Surprise	Garbage	1,260	15,120	42	380	16,000	8	8.0
Peoria	Garbage	2,754	33,048	92	380	35,000	18	18.5
El Mirage	Garbage	2,484	29,808	83	380	32,000	16	16.5
Private Hauler‡	Garbage	1,026	12,312	34	380	13,000	7	7.0
General Public	Type 2 & 3‡‡	1,640	19,680	55	Not available			
Total		17,724	212,688	591	Garbage only:		98	100.0

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98 Tons/day x 2,000 ÷ 60,000 = 3.3 Lbs/cap./day of "Garbage"

* Source: General Services Department, City of Glendale

** Calculated or estimated by John Carollo Engineers

‡ Includes Youngtown, Sun City, and Paradise Valley

‡‡ Unusually large items of rubbish

Table R-T12

GLENDALE, ARIZONA

LANDFILL RECORDS AND FACTORS CALCULATED

	RECORDS*								CALCULATED**				
	Landfill Life												
	Dates												
LF No. (1)	From (2)	To (3)	Days** (4)	Yrs** (5)	Refuse Recd CY (6)	Fill Placed Vol** CY (7)	Refuse*** Burned CY (8)	Population (9)	Annual Vol Recd CY (10)	Daily Vol Recd CY (11)	Annual Unit Vol Recd CY/Cap (12)	Vol Reduction Ratio (8)/(6) (13)	Annual Unit Vol Fill CY/Cap (14)
1	11/1/61	4/1/62	150	.41	20,000	24,500	900	25,000	48,800	134	1.95	1.2	2.34
2	4/1/62	3/1/63	334	.92	12,000	23,700	2,650	45,000	26,000	71	0.58	1.2	0.70
3	3/1/63	8/1/63	153	.42	71,000	80,000	2,160	47,000	169,000	460	3.60	1.1	3.96
4	8/1/63	8/1/66	1,096	3.00	600,000	336,000	2,200	56,000	200,000	548	3.57	0.6	2.14
5	8/1/66	7/1/67	334	.92	195,000	Not Available		60,000	212,000	591	3.53	Not Available	
	Totals		2,067	5.67	898,000			52,000***‡	(81,500)‡	223‡	1.57‡		
5‡‡	June 1967		14	.04	9,762	17,600	0	60,000	253,812	697	4.23	1.8	

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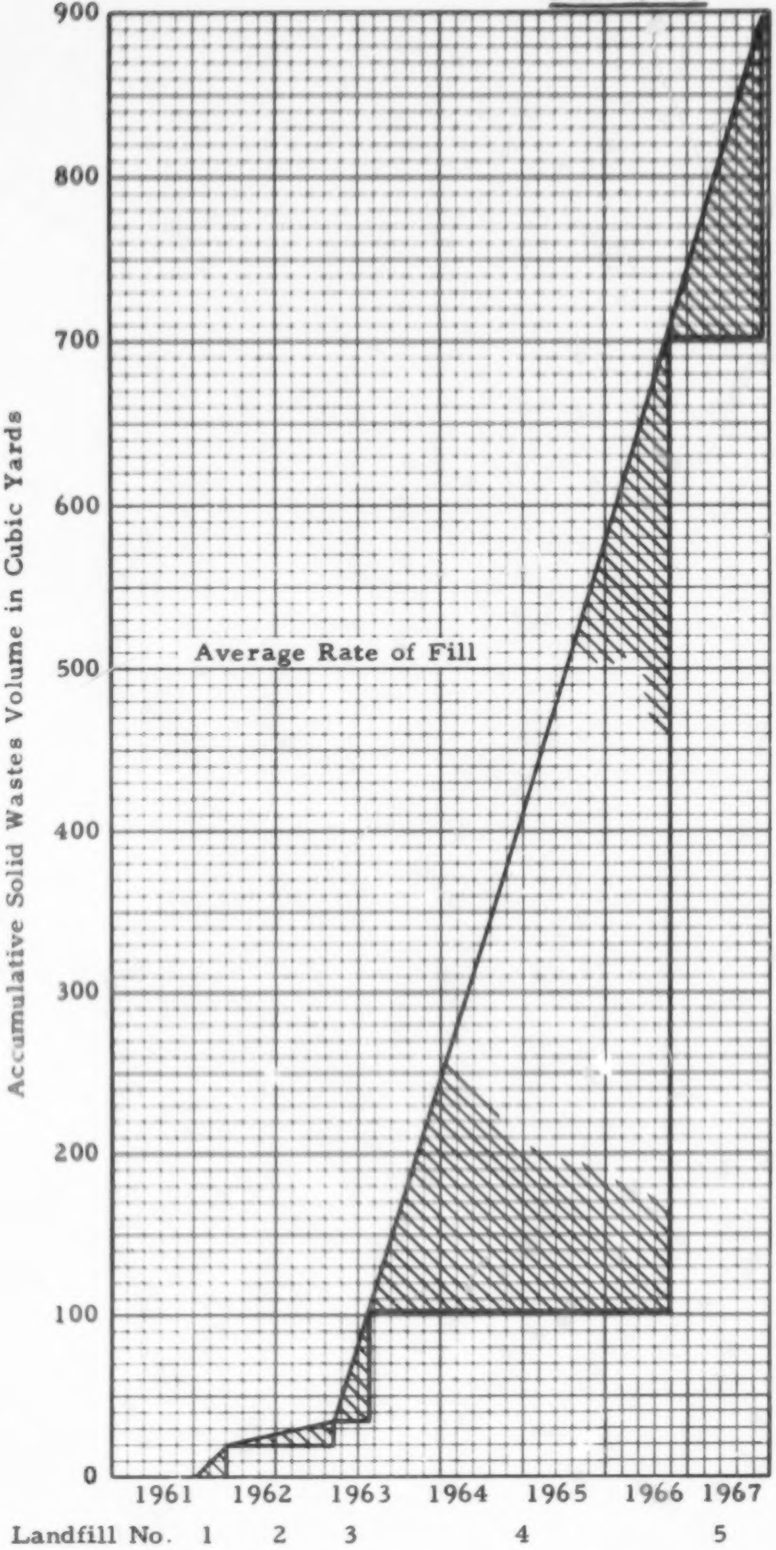
* Source: General Services Department, City of Glendale
** Calculated by John Carollo Engineers
*** No refuse was salvaged
‡ Weighted average
‡‡ Two-week test period record

Plate R-P9



1961 - 1967

Time Period 68 Months

Volume 898,000 CY

Annual Volume
(Cubic yards)

Min	Avg	Max
26,000 32%	81,500 100%	212,000 260%

Annual Unit Volume
(Cubic yards per capita)

Min	Avg	Max
0.58 37%	1.57 100%	3.60 230%

Average Day Volume
(Cubic yards)

Min	Avg	Max
71 30%	223 100%	591 265%

Current Practice
(2 Week test period)

Annual Volume	253,800 CY
Average Day Volume	697 CY
Annual Unit Volume	4.4 CY/cap

SOLID WASTES VOLUME TO LANDFILLS OPERATED BY CITY OF GLENDALE

Table R-T13

DISPOSAL OF DEAD ANIMALS IN METROPOLITAN MARICOPA COUNTY

	Disposal Agency (1)	Animal Types Disposed (2)	Method of Disposal (3)	Site of Disposal (4)	Amount Disposed On				
					Average Day			Peak Day	
					Count Each (5)	Avg Wt Lbs (6)	Wt Lbs (7)	Count Each (8)	Wt Lbs (9)
(a)	Maricopa County Veterinary Center	Pets*	Burial in special paper bags	Tri-Community landfill	Dogs 50 Cats 100	40 5	2000 500	70 200	2800 1000
(b)	Arizona Humane Society, Phoenix	Pets	Cremation	On-site incinerator	Dogs 10 Cats 30	40 5	400 150	35 100	1400 500
(c)	Arizona Humane Society, Tempe	Pets	Cremation	On-site incinerator	Dogs 10 Cats 30	40 5	400 150	35 100	1400 500
(d)	Veterinarians (120)	Pets	Crem.	(b) & (c)	180	12	2160	N.A.	N.A.
	Veterinarians	Pets	Burial	On-site, sealed pits	N.A.	N.A.	N.A.	N.A.	N.A.
(e)	Special Sanitation Crews	Pets, small stock**	Burial	Phoenix 15th Av LF	20	20	400	N.A.	N.A.
(f)	Total Est'd Count				430				
(g)	Total Est'd Weight						6200		
(h)	Phoenix Zoo	Special‡	Burial	On-site cem	0.2	1	.2	N.A.	N.A.
(i)	Private rendering works	Stock‡‡ Offal	Rendering	Rendering	100,000 to 200,000 Lbs			N.A.	N.A.

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* Pets are, principally, dogs and cats.

** Small stock includes those smaller than horses and cows.

N.A. means "Not Available."

‡ Zoo stock at 10% of stock annually, principally: small birds, reptiles, etc. Federal regulations require specific method of disposal of stock imported from foreign countries.

‡‡ Stock includes horses, cows, sheep, etc; offal is slaughterhouse and butchering wastes.

Table R-T14

MONTHLY SOLID WASTES TONNAGE TO TEMPE LANDFILL

Month	Compactors		Special Haul		Courtesy Trailer		Priv Vehicle		Total	
	Cu Yds	Tons	Cu Yds	Tons	Cu Yds	Tons	Cu Yds	Tons	Cu Yds	Tons
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Jan	10,200	2,295.0	247	24.7	972	48.6	2,149	214.9	13,568	2,583.2
Feb	9,100	2,047.5	322	32.2	972	48.6	2,079	207.9	12,473	2,336.2
Mar	10,420	2,344.5	237	23.7	1,242	62.1	2,125	212.5	14,024	2,642.8
Apr	9,620	2,164.5	127	12.7	540	27.0	2,196	219.6	12,483	2,423.8
May	10,200	2,295.0	128	12.8	5,274	263.7	2,127	212.7	17,702	2,784.2
Jun	9,880	2,223.0	210	21.0	1,188	59.4	2,493	249.3	13,771	2,552.7
Jul	9,480	2,133.0	125	12.5	1,026	51.3	2,461	246.1	13,092	2,442.9
Aug	9,400	2,115.0	201	20.1	1,242	62.1	2,664	266.4	13,507	2,463.6
Sep	9,460	2,128.5	180	18[illegible]	972	48.6	2,668	266.8	13,280	2,461.9
Oct	9,620	2,164.5	195	19.5	1,188	59.4	2,552	255.2	13,555	2,498.6
Nov	9,180	2,065.5	203	20.3	918	45.9	3,456	345.6	13,757	2,477.3
Dec	9,480	2,133.0	153	15.3	810	40.5	2,644	264.4	13,087	2,453.2
Total	116,040	26,109.0	2,328	232.8	16,344	817.2	29,614	2,961.4	164,299	30,120.4

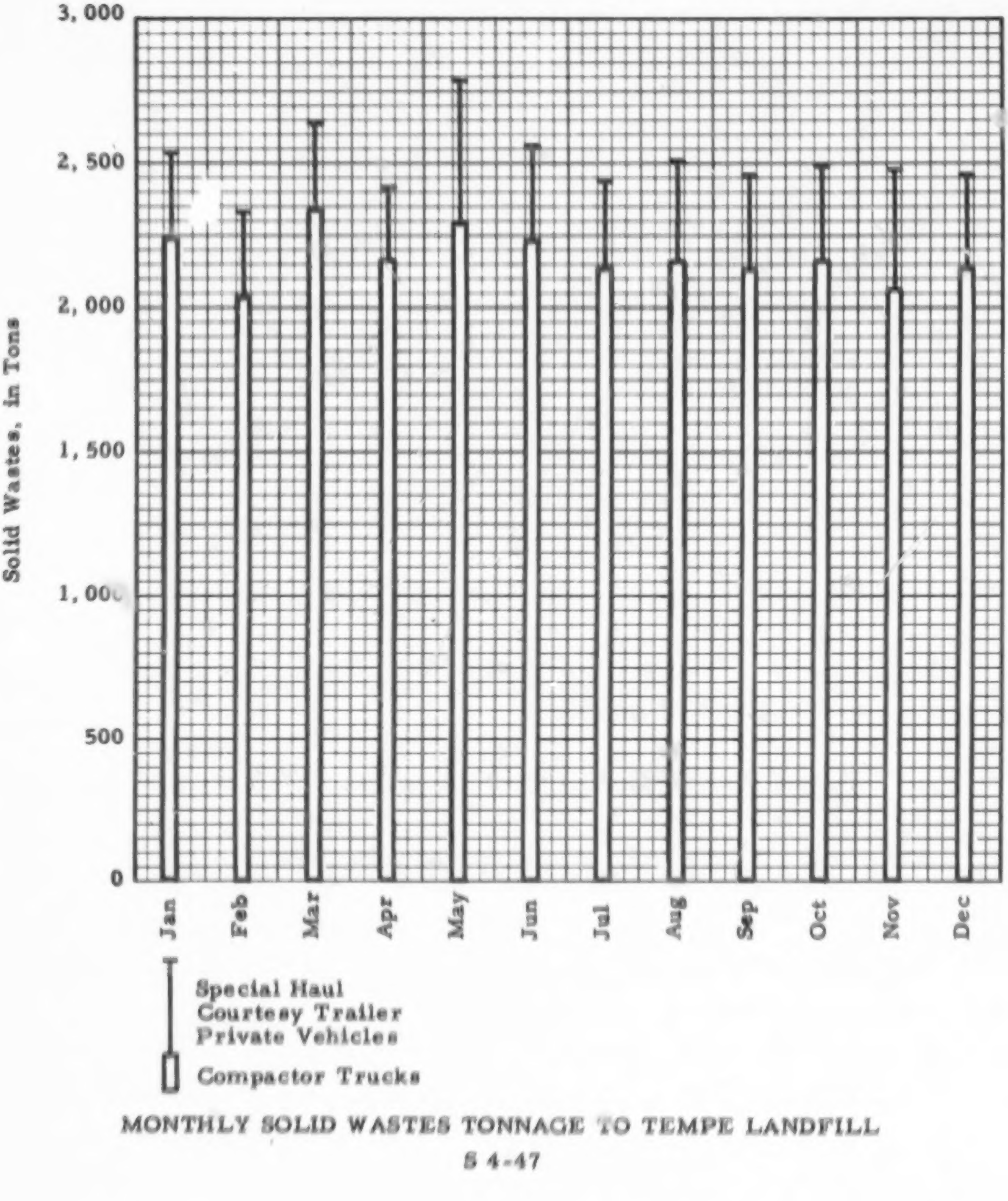
Volumes estimated by City from truck counts.

Densities estimated by City as:
- 450 lbs per cu yd for compactor trucks
- 200 lbs per cu yd for special haul (flat bed) trucks and private vehicles
- 100 lbs per cu yd for courtesy (open) trailers

Solid wastes disposal factors:
- 30,120 tons annual total
- 50,000 estimated population
- 3.3 lbs per capita per day

Plate R-P10

Factors: Average Month 2, 509 tons
Maximum Month 2, 789 tons or 111% of Average Month
Minimum Month 2, 329 tons or 93% of Average Month



MONTHLY SOLID WASTES TONNAGE TO TEMPE LANDFILL

COLLECTION AND HAUL

GENERAL: Requested information was not provided by all communities of the County concerning operations for the collection and haul of solid wastes. From the available information a listing has been made for inclusion herein of the agency, type of equipment, haul distance, and estimated costs for haul.

AGENCY: Solid wastes are collected and hauled within Maricopa County by municipal and private agencies that serve the general public and by individuals who serve their own needs. Municipal collection and haul is provided by Phoenix for residential solid wastes only. Commercial and industrial solid wastes in Phoenix are collected by private agencies.

Municipal collection and haul of residential, commercial, and industrial wastes are provided by Scottsdale, Mesa, Tempe, Glendale, Surprise, Tolleson, Avondale, Goodyear, Chandler, Wickenburg, and Gila Bend.

Private agencies collect and haul contained solid wastes in Paradise Valley, Youngtown, Cave Creek, Litchfield Park, Sun City, Aguila, and Queen Creek.

EQUIPMENT: Collection and haul equipment, exclusive of private vehicles, has been classified in the preceding section for the purpose of this study by type of function as:

1. Closed packer trucks for direct haul of solid wastes without rehandling to the disposal site.
2. Open trucks and trailers for direct haul of solid wastes without rehandling to the disposal site.

3. Container collector trucks for direct haul of containers of solid wastes without rehandling to the disposal site.

4. Container collector and compactor trucks for direct haul to the disposal site of solid wastes picked up in containers, emptied into the truck, and compacted within the truck.

Types 1 and 2 equipment are used by Phoenix, Tempe, Glendale, Avondale, Chandler, Wickenburg, and Gila Bend. Type 1 equipment is used in Paradise Valley, Surprise, Youngtown, Cave Creek, and Litchfield Park. Type 4 equipment, picking up from trailer trains of containers, is used in Scottsdale and Mesa. Private collection agencies in Phoenix collect commercial solid wastes in Type 1 and Type 4 equipment.

HAUL DISTANCE: For the purpose of this study, "haul distance" is the number of road miles by the shortest route from the centroid of a collection area to the disposal site. The centroid of a collection area is considered to be that point within the collection area at which the solid waste production is assumed to be concentrated. About the centroid of a collection area the sum is the least (in comparison to all other points) for the distances between the centroid and all pickup points within the collection area. In this study production (and pickup points) for solid wastes is assumed to vary with population density. Centroids for residential solid wastes within existing collection areas have been approximated on the basis of census tract population counts, on-site views of the areas, and reviews of detail maps. These centroids for the cities, towns, and unincorporated areas are identified in a subsequent subsection.

Haul distances vary from a minimum of one mile for Buckeye and Wickenburg to a maximum of twenty-three miles for Paradise Valley. Haul distances are tabulated in a subsequent subsection.

COSTS: Phoenix estimated in 1965 that the cost to the City for hauling one ton of solid wastes in a packer truck for a distance of one mile was $0.12 on arterial streets and $0.07 on freeways. On the basis of estimates of cost per load-mile as provided by Scottsdale, it is calculated that the cost to Scottsdale for hauling one ton of solid wastes in Type 4 equipment for a distance of one mile was $0.05.

PRODUCTION

GENERAL: Production of solid wastes is considered herein by classification as to origin of the solid wastes. For this consideration there are agricultural, residential, commercial, and industrial solid wastes. The greater part of the solid wastes problem in Maricopa County concerns residential, commercial, and industrial solid waste production in urban areas.

AGRICULTURAL SOLID WASTES: Solid wastes in Maricopa County include wastes from raising, processing, and packaging of vegetable and meat products. Agricultural solid wastes are defined, for this Report, as those solid by-products of agricultural production which become wastes prior to being transported from the agricultural community. For example, vegetable packing shed wastes are agricultural, but vegetable wastes from supermarkets are not agricultural.

In 1965 the distribution of farm acreage in Maricopa County included five major types of crops:

	Alfalfa	Citrus	Cotton	Grain	Vegetable	Total
Acres:	95,000	15,940	128,000	161,600	51,000	481,120

In 1967 there were about 200,000 head of beef cattle in feeding pens in Maricopa County and 50,000 head of dairy cattle.

As an industry of related parts, farming, ranching, dairying, and meat and poultry production is a vast complex in Maricopa County. Solid wastes are produced by this industry, but disposal of these wastes is generally accomplished within the industry.

Some examples of agricultural solid wastes are presented below to indicate the broad range of agricultural operations in the County, the type of wastes produced, and the common methods of disposal. Measurements have not been made by volume or weight of the total of agricultural solid wastes in the County.

Forage Crops. Alfalfa is a major forage crop in Maricopa County. It is grazed, baled for feed, and processed for seed. Solid wastes from this crop are readily disposed in the field.

Grains, processed primarily for seeds, produce a large volume of stems, leaves, and straw. This waste is generally disposed as stock feed or returned to the field where it is plowed under.

Fibre Crops. Cotton represents the largest single crop acreage in Maricopa County. Approximately 128,000 acres produce 70,000 tons of cotton annually. Roots, leaves, and stalks remain on the field. Baled cotton is separated at the gin into lint, seed, and trash.

Trash is returned to fields or burned.

In the processing of cottonseed to recover cottonseed oil, the by-products are meal and waste. An average of twenty pounds of waste results from one ton of cottonseed. This waste problem varies inversely with the need for roughage in compounded cattle feed. Some pesticides used on growing cotton render cotton wastes harmful in beef production. As a maximum, the annual tonnage of cottonseed waste could be about 350 tons in Maricopa County. Disposal on fields or in landfills is practiced and represents an operating cost to the ginning companies. However, it is a relatively insignificant part of the solid wastes problem in this County.

Edible Crops. Crops raised in Maricopa County for human consumption include lettuce, cantaloupe, watermelons, onions, carrots, celery, broccoli, cabbage, cauliflower, citrus, and grapes. Solid wastes from these crops normally remain in the field, are fed to the cattle, or are returned to the field. Some pesticides used on field crops render these wastes harmful as cattle feed. Some wastes broadcast over fields and left to rot are odorous and harbor insects.

Sugar beets are processed near Chandler in a plant of 4,250 tons per day capacity. Beet tops are fed to cattle. One ton of beets yields about 100 pounds of dried pulp for cattle feed. In washing beets, dirt is collected and subsequently wasted on private property. Other wastes are in the form of solutions and slurries.

Livestock. Of 306,000 head of cattle and calves on feed in Arizona on July 1, 1967, 191,000 were in Maricopa County. At the feeding pens the solid waste produced is manure. At two tons of manure per year per head*, it is estimated that nearly 400,000 tons of manure is produced annually in Maricopa County.

Offal from slaughterhouses is processed at rendering plants, which produces no solid wastes.

Fifty thousand dairy cattle in Maricopa County produce an estimated 50,000 tons of manure per year*.

Manure disposal is accomplished by spreading on fields for those farms and ranches that are remote from urban areas. Such disposal creates no problem. Manure odors from feeding pens that are adjacent to urban areas create a problem. Sanitary disposal of manure from feeding pens may be done in sanitary landfills.

RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL SOLID WASTES: As previously stated, the greater part of the solid wastes problem in Maricopa County concerns residential, commercial, and industrial waste production in cities, towns, and other urban areas. Collection is measured in the quantities received at disposal sites. Production quantities are estimated from collection quantities. Quantity is one of the two principal factors of solid waste production that affects costs. Source is the second principal factor of solid waste production that affects costs.

Costs of solid wastes handling are evaluated in this Report as "haul" costs and "disposal" costs. Haul costs are expressed in terms of dollars per ton-mile spent in transporting solid wastes from centroids of production areas to the disposal site. Disposal costs are expressed in terms of dollars per ton spent in disposal operations (sanitary landfill, landfill, dump, or burning dump).

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*Bulletin A-36, University of Arizona

The weight factor in both costs is the quantity factor. Each quantity factor is the product of the area population times the per capita rate of production. Area populations have been estimated and projected in a previous section of this Report. Per capita rates of production are discussed below.

The distance factor in the haul cost is the source factor. Distance is determined by the road mileage between the production centroid and the disposal plant. Production centroids are discussed below.

Rates of Production. Disposal policies significantly affect the disposal program. Construction and demolition wastes are more commonly disposed of by the contractors in locations where solid fill may benefit a relatively small site near the source of waste. Municipal disposal sites in Maricopa County more commonly do not accept construction and demolition wastes. At landfills, where all solid wastes can be accepted, policy determines what may be accepted. At incinerators, where only combustible wastes can be reduced in volume by burning, policy is dictated by the limitations of the incineration method.

Policy may dictate the method of disposal, as in Los Angeles County, where policy has prescribed facilities for disposal of all solid wastes. This policy has resulted in the operation of landfills on a large-scale, long-term basis to the exclusion of incineration.

Technical literature purporting to record the magnitude of solid wastes problems is beset by a confusion of terminology and results in nonspecific presentations which defy strict analysis. Data reported from many cities of the United States have been reviewed. The tabulation below summarizes selected data which account to a reasonable degree for the four basic factors: time, weight, population, and kinds of waste.

SOLID WASTE DISPOSAL RECORDS

by Selected Agencies

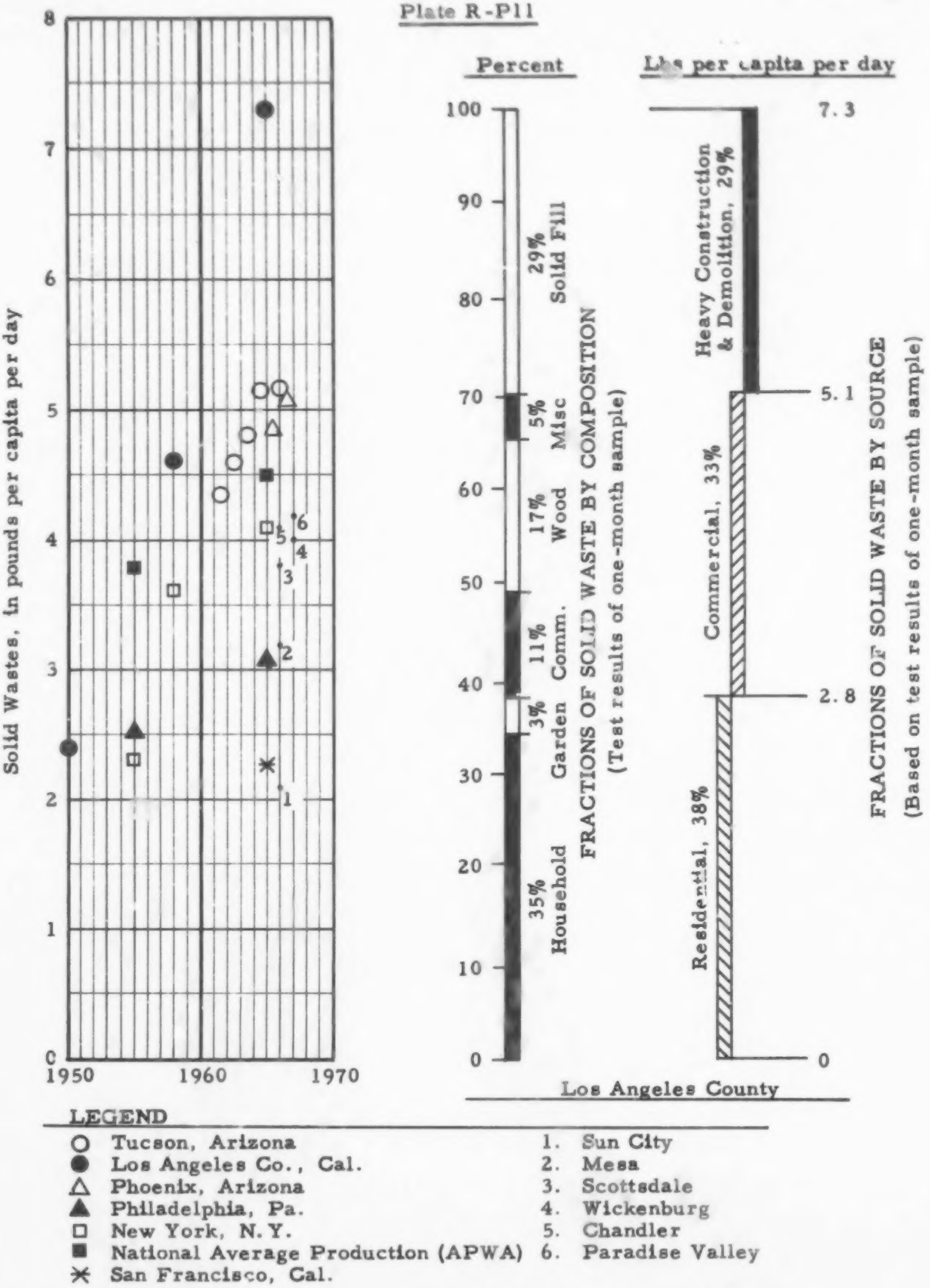
	Unit Weights in Lbs/Cap/Day								
Plan	1950	1955	1958	1961	1962	1963	1964	1965	1966
Arizona									
Phoenix								4.8 RC	5.1 RC
Scottsdale									3.8 RC
Mesa									3.2 RC
Tucson				4.3 ?	4.6 ?	4.8 ?	5.1 RC	5.1 RC	
New York City		2.3	3.6					4.1 RC	
Philadelphia		2.5						3.1 Rc	
Los Angeles County	2.1		4.6					6.5 SW	
San Francisco								2.3 R	

R indicates all Residential wastes included
C indicates all Commercial wastes included
c indicates part Commercial wastes included
SW indicates all Solid Wastes

Data tabulated above is plotted on Plate R-P11 (Page S 4-56)

"National Average Production (APWA)" is also plotted on that graph.

Plate R-P11



TRENDS OF UNIT WEIGHTS IN SOLID WASTES COLLECTION

The American Public Works Association data are taken from questionnaires completed by numerous agencies in the United States. It is not clear what is meant by "production" in this case. In 1965 4.5 pounds per capita per day was computed as "average production." That figure is referred to repeatedly in technical literature and is included here to raise the question of its full meaning wherever it is encountered.

It is evident from the selected records that more accurate ratios of kinds of waste are desirable. For example, the San Francisco record is reported as 2.3 pounds of residential waste per capita per day. We have assumed this represents nearly all residential wastes, but not all, because there is a specific charge by amount collected at each site. Some residents will haul their own wastes part of the time to avoid the charge. In a large city the length of haul will deter residents from hauling their own wastes. Residential wastes in San Francisco are considered to be between 2.0 and 2.5 pounds per capita per day.

In Phoenix, where city trucks collected residential garbage and trash, the loads have been weighed for about two years. At about 5.0 pounds per capita per day of solid wastes consisting of all the residential and commercial wastes, 53 percent of 2.64 pounds per capita per day has been residential (see Plate R-P4, Page S 4-34). "Licensed trucks" are operated on regular collection schedules by private firms. They hauled 25 percent or 1.28 pounds per capita per day of commercial wastes. Some residents and some commercial businesses hauled their own wastes part of the time. "Public dumpers" are dump trucks, privately owned; and "free vehicles" are nondumping. They hauled 0.65 and 0.20 pound per capita per day, respectively.

Considering "free vehicles" as residential, the maximum for residential wastes would have been about 2.8 pounds per capita per day. Considering "public dumpers" as commercial, the maximum for commercial wastes would have been about 1.9 pounds per capita per day. Distinction between "commercial" and "industrial" classes of wastes is not made in these records. The range of residential plus commercial wastes in Phoenix was 3.9 to 4.7 pounds per capita per day.

Tucson data supports Phoenix data at about 5.1 pounds per capita per day of residential plus commercial solid wastes. Weighing is less accurate in Tucson and Los Angeles County than it is in Phoenix. Samples are weighed and an average truckload weight applied to a truck count in Tucson and two-thirds of Los Angeles County's solid wastes. One-third of Los Angeles County's solid wastes is weighed.

Los Angeles County accepts all solid wastes delivered to disposal sites. Sample testing has indicated that 46 percent of total solid wastes delivered was construction plus demolition wastes. About 50 percent of all solid wastes is expected, by that agency, to continue to be construction and demolition wastes as obsolescence of old buildings and highways will require replacement at a steady rate. "Household" wastes were 35 percent of the total. Of 9, 000, 000 tons per year reported into 31 sites and representing 7.3 pounds per capita per day, about 3, 000, 000 tons were weighed into the landfills operated by the Sanitary Districts of Los Angeles County. From a one-month record of weighed solid wastes, percentages of weights by kinds or source were as follows:

Kind or Source	Per-cent	Lb/Cap /Day*
Household	35	2.6
Commercial	11	0.8
Wood	17	1.2
Brush and garden	3	0.2
Solid fill	29	2.1
Miscellaneous	5	0.4
Total	100	7.3

*Based on a total of 7.3 for 31 sites

Corresponding to the terms "residential" plus "commercial" used in Phoenix, the total would be at least 3.5 pounds per capita per day (Household + Brush and Garden + Commercial). The most would be 5.2 (Total - Solid Fill). The average of those two rates is 4.4.

Data presented on Plate R-P11 (Page S 4-56) is interpreted as follows:

1. Tucson data prior to 1965 represents only part of the total solid wastes collected for disposal. A transition period (spanning 1962, 1963, and 1964) was characterized by two factors:

    a. City collection replaced private collection as city limits expanded and private collection was phased out.

    b. City disposal progressively provided for a larger share of solid wastes as Pima County Sanitary District disposal activities decreased.

Under these circumstances evaluation of data is questionable. No line is drawn connecting the points representing Tucson data because the points are interpreted to be not comparable.

By 1966 Tucson was collecting about 97 percent of all solid wastes for disposal from residential, commercial and light industrial sources. Their equipment was standardized and record keeping more complete and reliable. With city limits stabilized the population contributing to the waste was known accurately enough for this purpose. Tucson is presently disposing of 5.2 pounds per capita per day from residential and commercial sources.

2. Phoenix records are considered the most accurate of all records reviewed. All solid wastes disposed at City landfills were weighed, the City Limits were stable, and the contributing population was known accurately enough for this purpose. Phoenix is presently disposing of 5.1 pounds per capita per day from residential and commercial sources.

3. Los Angeles County solid wastes are buried at about 31 sites now. The number and location of sites vary in time as do the operating agencies. Five of these sites receive about one-third of the total solid wastes received at the 31 sites.

Those five sites, operated by the Sanitary Districts of Los Angeles County, are equipped with weighing scales. Data from those five sites are considered to be accurate. The combined data are necessarily less accurate, not being based on accurate weights and involving methods of numerous agencies. However, the application of the one-month test sample results to the rate of total reported collection in the county amounts to 5.1 pounds per capita per day from residential and commercial sources, the same as Phoenix.

4. The "National Average Production" rate of solid wastes as reported by the American Public Works Association is interpreted to be an average of numbers reported from many sources and of unknown value for the purposes of this Report.

5. The significance of the San Francisco data is that it probably represents less than the total residential solid waste from the population contributing and none of the commercial waste. It represents a lower limit for residential solid wastes only, 2.3 pounds per capita per day.

6. Philadelphia data are reported to represent residential plus "some" commercial solid wastes. Then 3.1 pounds per capita per day represents an upper limit for residential solid wastes.

7. Los Angeles data indicate residential solid wastes represent 2.8 pounds per capita per day. Phoenix hauled 2.6 pounds per capita per day in garbage and trash trucks from residential sources, plus about 0.1 in Parks and Recreation Department trucks, plus about 0.1 in free vehicles for a total of 2.8 pounds per capita per day, "residential."

8. For larger cities, representing all types of residential zones and "free" pickup service, residential solid wastes amount to about 2.8 pounds per capita per day.

9. Sun City and Paradise Valley are predominantly residential communities. But they are not similar in character. Sun City, a young, affluent, over-fifty, retirement community without children, contributed only 2.1 pounds per capita per day. Paradise Valley, a young, affluent, family community contributed 4.2 pounds per capita per day. That range, 2.1 to 4.2, was reported from the same source, a private collector, who counts truck loads and spot checks load weights. These data indicate that smaller, residential communities with controlled, uniform zoning produce solid wastes at a rate characteristic of their type of residents. Retired, older persons without children would be expected to buy less and waste less than younger families with children. An average rate of solid waste production results from a large city having a broad range of resident types. A less wasteful neighborhood would produce waste below that average rate, and a more wasteful neighborhood, above the average. Phoenix produced 2.8; Sun City, 2.1; and Paradise Valley, 4.2.

10. Mesa and Scottsdale, intermediate sized cities, have broader ranges of residential zoning than Sun City and Paradise Valley. Their collection methods combine residential and

commercial wastes, and their rates of residential collection are indeterminate. Their records are kept by volume rather than weight. Spot weighing of truckloads in Scottsdale and truckload counts are the basis for determining their waste production rate, 3.8 pounds per capita per day, of residential plus commercial.

Mesa collection includes brush hauled in open trucks without compaction. The average density of loaded brush was estimated at 200 pounds per cubic yard. For Mesa 3.2 pounds per capita per day is less reliable than 3.8 for Scottsdale, but it is considered to be plus or minus 0.2. Then Mesa might be producing as low as 3.0 or as high as 3.4 and certainly less than Scottsdale.

11. There is no significant difference in rates of solid waste production from Wickenburg and Chandler at 4.0 and 4.1 pounds per capita per day, respectively.

Collection of residential and commercial solid wastes is combined in both places. Both are isolated communities on major highways with commercial wastes produced from highway oriented businesses.

Uniform accounting by weight for rates of solid waste collection can be related directly to contributing population in only one community of the many considered. That community is Phoenix and the record is only for two years. Therefore no trend toward greater per capita solid waste production or collection has been determined.

Projections of future solid waste production for this study are, therefore, computed from population projections as one factor and constant per capita production rates as the other. Production rates used to project solid wastes for communities are listed below:

SOLID WASTE RATES

(Pounds per Capita per Day)

Place	Received at Landfills 1967	Projected Production
Phoenix	5.1	5.5
Avondale		4.5
Buckeye		4.5
Cave Creek		4.5
Chandler	4.1	4.5
El Mirage		4.5
Gila Bend		4.5
Gilbert		4.5
Glendale		4.5
Goodyear		4.5
Litchfield Park		4.5
Mesa	3.2	4.5
Paradise Valley	4.2	4.5
Peoria		4.5
Scottsdale	3.8	4.5
Surprise		4.5
Tempe		4.5
Tolleson		4.5
Wickenburg	4.0	4.5
Sun City	2.1	2.5
Youngtown		2.5

Production Centroids. As previously stated, one purpose of locating production centroids is to determine haul distance for haul cost evaluation. Another purpose is to determine the "minimum mean haul" from a production area. Minimum mean haul is the distance that solid wastes would have to be transported if disposal were accomplished at the production centroid.

Each urban area in the County (except Phoenix) hauls to one disposal site and is considered to have one production centroid for each area. Production centroids for these areas were located subsequent to on-site approximations and reviews of maps.

Phoenix has three disposal sites and is considered to have one production centroid related to each site. Production centroids for Phoenix were located subsequent to an analysis of population distribution maps and land use maps.

The centroid of all wastes production should be used in developing a disposal plan. However, data have not been made available by private collector firms. Consequently, the plan can be based upon the residential wastes production but cannot be based upon the centroid of all solid wastes production. Private haulers collect nearly half of the total wastes delivered to landfills in Phoenix.

Residential solid wastes have been assumed to be produced uniformly in proportion to population distribution. Population distribution is not uniform, of course. The centroid of population was computed from detailed population estimates for each square mile within the Phoenix study area.

Commercial plus industrial solid wastes from Phoenix are estimated by identifying the amounts hauled to landfills by various haulers. Commercial and industrial solid wastes were collected and hauled in Phoenix by three private firms and disposed of at two sanitary landfills during fiscal year 1967 as indicated in Table R-T15 (Page S 4-65). Uniform distribution of commercial plus industrial solid wastes cannot be assumed over a predominantly residential area.

Table R-T15

MONTHLY SOLID WASTES TONNAGE
COMMERCIAL PLUS INDUSTRIAL

Phoenix Landfill, 15th Avenue and Salt River

	Month (1)	Private Firms A (2)	 B (3)	 C (4)	Cash or Credit (5)	Yearly License (6)	Totals (7)
1966	Jun	-	1,539	1,477	3,496	4,541	11,053
	Jul	-	1,480	1,588	1,807	3,843	8,718
	Aug	206	1,660	1,754	2,769	4,354	10,743
	Sep	238	1,542	1,693	1,722	4,353	9,548
	Oct	298	1,527	1,828	1,637	4,520	9,810
	Nov	355	1,952	1,737	1,643	4,126	9,813
	Dec	278	2,255	2,114	2,039	3,346	10,032
1967	Jan	408	2,282	1,968	2,050	3,598	10,306
	Feb	292	2,473	1,854	1,984	2,936	9,539
	Mar	315	2,715	2,409	2,105	3,985	11,529
	Apr	349	2,173	2,045	2,169	3,832	10,568
	May	244	2,700	2,460	2,130	4,332	11,866
Totals		2,983	24,298	22,927	25,551	47,766	123,525
Tons per Calendar Day							338
Tons per Collection Day							395

Phoenix Landfill, 19th Avenue and Greenway

	Month (1)	Private Firms A (2)	 B (3)	 C (4)	Cash or Credit (5)	Yearly License (6)	Totals (7)
1966	Jun	426	524	241	2,595	660	4,446
	Jul	474	640	292	1,812	507	3,725
	Aug	506	634	321	2,585	577	4,623
	Sep	536	595	250	2,380	523	4,284
	Oct	395	635	346	1,808	909	4,093
	Nov	418	513	377	1,543	1,362	4,213
	Dec	418	480	302	1,831	1,615	4,646
1967	Jan	395	353	263	1,836	1,789	4,636
	Feb	334	209	259	1,581	1,712	4,095
	Mar	403	276	270	1,901	1,919	4,769
	Apr	511	288	229	1,868	1,509	4,405
	May	573	345	309	1,984	903	4,114
Totals		5,389	5,492	3,459	23,724	13,985	52,049
Tons per Calendar Day							143
Tons per Collection Day							166

Commercial plus industrial areas were plotted from data presented on maps in a land use report prepared by Maricopa County Planning and Zoning Department. For lack of better data it was assumed that wastes were produced uniformly over that commercial plus industrial area.

Centroids were calculated for commercial plus industrial areas within three residential collection areas in Phoenix. In this case areas were used instead of populations. The areas are indicated on Plate R-P12 (Page S 4-67).

We have determined that the estimated centroids for residential and for commercial plus industrial differ as follows:

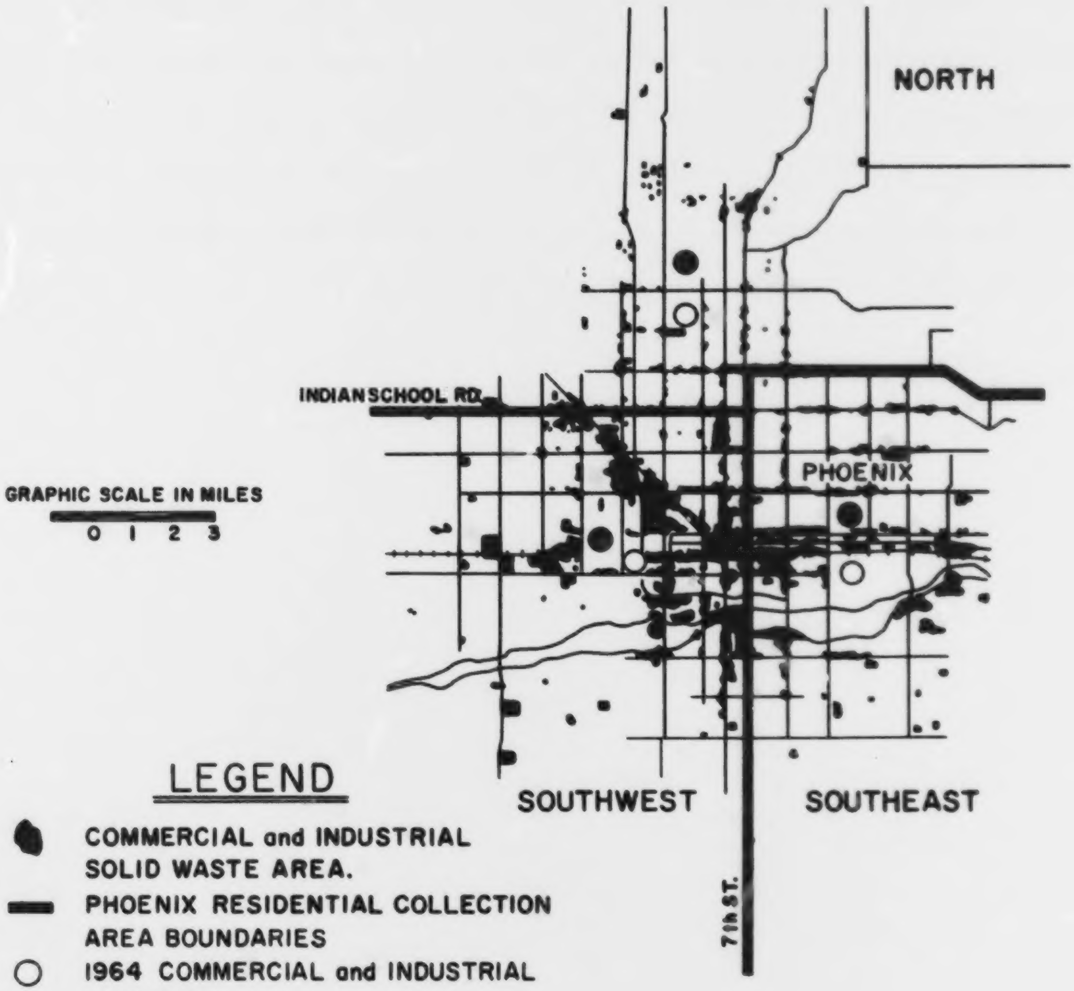
N 1/2 Phoenix	2 miles
SW 1/4 Phoenix	1 mile
SE 1/4 Phoenix	1-1/2 miles

The commercial plus industrial centroid, based upon commercial plus industrial areas, is not as valid as the residential centroid. The weighted average centroid cannot be computed from data available.

An analysis of haul costs for commercial and industrial solid wastes cannot be calculated for lack of data.

No attempt was made to determine commercial or industrial centroids in other cities and towns.

Plate R-P12


NORTH
INDIANSCHOOL RD.
PHOENIX
GRAPHIC SCALE IN MILES
0 1 2 3
SOUTHWEST
SOUTHEAST
7th ST.

LEGEND

- ● COMMERCIAL and INDUSTRIAL SOLID WASTE AREA.
- ▬ PHOENIX RESIDENTIAL COLLECTION AREA BOUNDARIES
- ○ 1964 COMMERCIAL and INDUSTRIAL CENTROID
- ● 1967 POPULATION CENTROIDS

SOURCE OF COMMERCIAL AND INDUSTRIAL SOLID WASTE, CITY OF PHOENIX —1964

Location of Commerical and Industrial Areas From Part Two of the Comprehensive Plan For Maricopa County. Prepared by the Maricopa County Planning Department.

SUMMARY

Rates of production of residential, commercial, and industrial solid wastes are estimated for the present and future on a pounds per capita basis to be 2.5 for Sun City and Youngtown, 5.5 for Phoenix, and 4.5 for all other urban areas in the County. Records and estimates concerning other phases of solid wastes operations in Maricopa County are summarized in Table R-T16 (Page S 4-69).

Table R-T16

SOLID WASTES OPERATIONS IN MARICOPA COUNTY - 1967

COLLECTION					HAUL				DISPOSAL						
			Weight		Equipment									Operational Costs	
Source (1)	Population (2)	Centroid Location (3)	Cu Yd per Day (4)	Tons per Day (5)	Residential (6)	Coml & Indust'l (7)	Distance Road Mi (8)	Cost $/Ton Mile (9)	Method (10)	Site Location (11)	Site Owner (12)	Site Operator (13)	Site Life Remaining Years (14)	$/Cu Yd (15)	$/Ton (16)
(Five Major Cities)															
1. Phoenix	518,000	Central Ave & Indian Schl Rd		1,323	(1) & (2)	1 & 4		$0.12/ $0.07							1.65
a. North	194,000	19th Ave & Glendale Ave		450			6.0		Landfill	19th Ave & Greenway Rd	Priv. & Cty Phx	City of Phoenix	5.5	–	–
b. Southwest	146,000	27th Ave & Van Buren		615			3.5		Landfill	15th Ave & Salt River	Private	City of Phoenix	2.0	–	–
c. Southeast	178,000	32nd St & McDowell Rd		258			4.0		Landfill	16th St & Salt River	Private	City of Phoenix	1.5	–	–
2. Scottsdale	58,400	Scottsdale Rd & Thomas Rd	443	108	4	4, (4)	5.0	$0.05	Landfill	Country Club Dr & Salt Riv	S.R.-Pim -Maric	Salt Riv - Pima - Maricopa	*	0.19	0.46
3. Mesa	53,200	Mesa Dr & Main St	460	85	1 & 2	1 & 2	5.0	*	Landfill	Country Club Dr & Salt Riv	Com Trib Council	Community Tribal Council	*	0.20	
4. Tempe	48,000	Mill Ave & Apache Blvd		93	1 & 2	1 & 2	2.0	*	Sanitary Landfill	Hardy Dr & Salt River	City of Tempe	City of Tempe	1	–	0.95
5. Glendale	33,000	51st Ave & Glendale Ave	285		1 & 2	1 & 2	8.5	*	Sanitary Landfill	103rd Ave & Olive Ave	Private	City of Glendale	1	0.38	–
(Thirteen Minor Cities and Towns)															
6. Paradise Valley	2,400	60th St ext & Cheney Dr		5.0	(1)		23.0	*	Sanitary Landfill	103rd Ave & Olive Ave	Private	City of Glendale	1	*	–
7. Surprise	2,400	Nash St & Grand Ave	42		1		7.0	*	Sanitary Landfill	103rd Ave & Olive Ave	Private	City of Glendale	1	0.18	–
8. El Mirage	3,300	Primrose St & Ventura St	83		*		5.5	*	Sanitary Landfill	103rd Ave & Olive Ave	Private	City of Glendale	1	0.13	–
9. Youngtown	1,900	114th Ave & Connecticut	*		(1)		3.0	*	Sanitary Landfill	103rd Ave & Olive Ave	Private	City of Glendale	1	*	–
10. Peoria	4,000	Central Ave & Peoria Ave	*		*		3.5	*	Sanitary Landfill	103rd Ave & Olive Ave	Private	City of Glendale	1	0.14	–
11. Tolleson	5,200	93rd Ave & Van Buren	*		1	1	3.5	*	Dump	91st Ave & Salt River	City of Toll's'n	City of Tolleson	*	*	
12. Goodyear	1,900	Litchfield Rd & Loma Linda	*		*		3.5	*	Landfill	El Mirage & Broadway	Maricopa County	City of Avondale	*	*	
13. Avondale	6,900	Central Ave & Western Ave	*		1 & 2	1 & 2	4.5	*	Landfill	El Mirage & Broadway	Maricopa County	City of Avondale	*	*	
14. Gilbert	1,900	Gilbert Rd & Elliott Rd	*		*		3.0	*	Landfill	Val Vista Rd & Ray Rd	Maricopa County	City of Chandler	1	*	–
15. Chandler	14,600	Arizona Ave & Cleveland St		30.0	1 & 2	1 & 2	6.0	*	Landfill	Val Vista Rd & Ray Rd	Maricopa County	City of Chandler	1	–	0.18
16. Wickenburg	2,400	Apache St & Washington		4.8	1 & 2	1 & 2	1.0	*	Burning Dump	W 1/2 NE 1/4 Sec 14 TN	State of Arizona	City of Wickenburg	*	*	–
17. Buckeye	2,500	Main St & Monroe Ave	*		*		1.0	*	Burning Dump	1st St & Salt River	*	City of Buckeye			
18. Gila Bend	1,900	Martin Ave & Pima St	*		1 & 2	1 & 2	4.0	*	Burning Dump	Sec 20 R 4 W	*	Maricopa County	*	*	–
(Unincorporated Centers)															
19. Cave Creek	1,200	SW 1/4 Sec 27	*		(1)		3.0	*	Dump	Sec 9, Carefree Hwy		Maricopa County			
20. Sun City	11,000	103rd Ave & Sun City Dr		11.5	(1)	(1)	2.0	*	Sanitary Landfill	103rd Ave & Olive Ave	Private	City of Glendale	1	*	–
21. Litchfield Park	3,400	Litchfield Rd & Indian Schl Rd			1	1	8.0	*	Landfill	El Mirage & Broadway	Maricopa County	City of Avondale	*	*	

*	No data provided or available
Col 2	Estimated by interpolation from "Population Records and Forecasts"
Col 4 & 5	Record as 100; estimate as 100
Col 6 & 7	Municipally operated as 3; privately operated as (3) 1 = Closed packer trucks for direct haul 2 = Open trucks and trailers for direct haul 3 = Container collector for direct haul 4 = Container collector and compactor for direct haul
Col 8	Distance (one way) between population centroid and disposal site
Col 9	For Phoenix, $0.12 on arterial streets and $0.07 on freeways

SECTION 5

ANALYSIS OF SOLID WASTES DISPOSAL PROGRAMS IN MARICOPA COUNTY

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SECTION 5 - ANALYSIS OF SOLID WASTES DISPOSAL PROGRAMS IN MARICOPA COUNTY

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SECTION 5

ANALYSIS OF SOLID WASTES DISPOSAL PROGRAMS IN MARICOPA COUNTY

GENERAL

Current solid wastes disposal programs and future disposal programs are analyzed in this section. Disposal of solid wastes on land is recommended in Section 6 of this Report. Open dumps, burning dumps, and landfills are not satisfactory facilities for sanitary disposal on land. Sanitary landfill is the only satisfactory method for sanitary disposal on land. There are no municipal incinerators in Maricopa County. There are salvage operations but not associated with composting of putrescible solid wastes. Municipal disposal of solid wastes in bodies of water is not practical in the County.

CURRENT MUNICIPAL DISPOSAL METHODS

At the beginning of this study in midyear 1967 Glendale and Tempe were operating sanitary landfills. Phoenix was not covering its landfills daily but is now taking the progressive steps to attain sanitary landfill operations at all three sites. The Scottsdale-Mesa-Indian Community site was operated as an open dump at the beginning of this study. At the last inspection trip the site had been cleaned and covered on the finished surface, solid wastes were being placed and compacted in an orderly manner, and earth cover was apparently only one day behind compaction. Chandler and Gilbert had a critical condition at their disposal site in early 1967. They have completed their site study, purchased new equipment, and are progressing rapidly toward attaining a sanitary landfill operation.

We expect that by the publication date of this Report solid wastes disposal in sanitary landfills will include those from El Mirage, Paradise Valley, Peoria, Surprise, Youngtown, Sun City, Glendale, Mesa, Phoenix, Scottsdale, Tempe, Chandler, Gilbert, and some parts of the dispersed population. Those populations represent about 86 percent of the total population of the County.

Luke Air Force Base cooperates with Glendale in disposing of solid wastes at the Glendale sanitary landfill. Williams Air Force Base reported their solid wastes are disposed on the base by sanitary landfill under a private collection-disposal contract.

Municipal, County, and Federal officials responsible for operating the sanitary landfills in Maricopa County merit recognition. Most metropolitan areas of our nation have not done as well to date.

Eight communities are expected to be depositing solid wastes in dumps at the publication date of this Report. Those eight are Avondale, Buckeye, Cave Creek, Gila Bend, Goodyear, Litchfield Park, Tolleson, and Wickenburg. Those populations represent about 3 percent of the total population of the County.

Avondale, Goodyear, and Litchfield Park can attain sanitary landfill disposal and eliminate brush burning at their present disposal site by correcting their operations. Buckeye, Gila Bend, Tolleson, and Wickenburg need new programs and equipment to solve their present disposal problems.

A large part of the dispersed population of the County has neither collection nor disposal programs. This group represents about 10 percent of the total County population.

National solid wastes disposal efforts are concentrated on densely populated metropolitan areas because the problems in those areas are the larger. In Maricopa County the solid wastes disposal problems more difficult to solve are near small communities and dispersed populations. The small communities have not budgeted for sanitary landfill before, and the method is relatively expensive as compared to open dumping with or without open burning. Solid wastes produced by dispersed populations would require long haul. Collection cost would be high as compared to urban collection cost. Rural collection, haul, and sanitary disposal is only practical in urban fringe areas.

DISPOSAL PROGRAMS, 1968-1970

Long-term planning by municipalities and the County is necessary for disposal of solid wastes by the sanitary landfill method. Costs of haul are normally more than costs of disposal by sanitary landfill. Each cost may be estimated for each alternate landfill site. A land use plan for each alternate site may be developed. The increased site value may be estimated as a benefit. A series of most feasible sites may be determined as a basis for future municipal disposal provisions.

Sensational reports of impending national submergence in solid wastes need not be a factor in an approach to disposal programs in Maricopa County. We have adequate streets and highways to haul solid wastes on and programs to add more. We have vacant land suitable for disposal sites at reasonable haul distances. There is no promise of new disposal technology which might give cause for delay or half measures in planning a long-term sanitary landfill disposal program.

GLENDALE AREA PROGRAM: The City of Glendale has quietly developed a program of great benefit to themselves and their neighboring communities. This program is based upon voluntary cooperation of governments, private industry, and private individuals. The program works because it efficiently meets the needs of each participant.

Glendale officials have negotiated with farmers for landfill sites. The sites are chosen for convenient haul from all cooperating communities. The sites are made available at no direct land cost. When completed, the sites have been improved from unproductive to productive agricultural land.

Costs of disposal are shared on a per capita basis by each agency using the sanitary landfill. Glendale's population is about 35,000, but the contributing population to their disposal site is about 70,000. The unit cost to Glendale, in dollars per ton, is less than it would be if they were operating alone at one-half their present disposal rate. The other participating communities not only benefit at the lower unit cost of disposal but probably could not finance any method of sanitary disposal on an individual basis. The County uses the opportunity to provide sanitary disposal facilities to part of their dispersed population.

Glendale has written or oral agreements with landowners assuring available disposal sites for about the next decade. Some of the oral agreements could be confirmed in writing if the operating time period could be determined that far in advance.

The principal deficiency in this program is lack of basic data on volume of tonnage in place and detailed plans for each site combined into an integrated program.

The Glendale area disposal program reflects the positive attitude of responsible officials that sanitary disposal will be attained; that the benefits in cost, sanitation, and appearances extend across municipal boundaries; and that disposal technology adequate for this area can be applied now.

PHOENIX AREA PROGRAM: The City of Phoenix Public Works Department manages a cooperative disposal program which provides for sanitary disposal of residential, commercial, and industrial solid wastes produced in the City and in the urban fringe areas. In 1967 about 518,000 persons contributed about 500,000 tons to the three disposal sites. One ton of solid wastes occupied two cubic yards of space, on the average, at the 16th Street Landfill. At that rate the annual tonnage occupies about 1,000,000 cubic yards.

The problem solution in the Glendale area was to develop a larger tonnage basis to reduce unit costs. The tonnage basis for Phoenix exists, and the problem is to provide good disposal sites.

Selection and acquisition of adequate disposal sites is a critical deficiency of the Phoenix program. In the past Phoenix has operated dumps and created resistance to establishment of new disposal sites. Recently landfilling has succeeded dumping, and the public image of disposal sites may have improved some. With the current effort to attain planned sanitary landfill operations and attractive land use, the public image of disposal sites can be improved more. The effectiveness of disposal site acquisition effort is limited by the public image of disposal sites. Plans for new sites must consider the public desire for beneficial land use. But plans are not enough. Beneficial, attractive land use on old sites must be demonstrated.

The accepted long-term planning tools of public works have been applied to other public works programs in Phoenix. These include streets and highways, the water system, and the sewerage system. A similar approach to broad, long-range engineering plans is needed now in solid wastes disposal studies. This Report can be a part and further detailed site studies are under study by the City for a calculated program of disposal site acquisition and development. Without a program comparable to other public works programs, budgeting and management of the solid wastes program is at a disadvantage.

TEMPE AREA PROGRAM: Competence to operate a sanitary landfill is demonstrated by the City of Tempe at a central location adjacent to the Salt River. Plans for the site include future land use after gravel and sand excavations and landfill operations are completed. By placing inert, dense demolition wastes along a planned alignment, erosion control is being established. This feature, as in Phoenix, demonstrates a beneficial use of waste materials which can be applied at many locations along the Salt River channel.

Tempe disposes of solid wastes for a population of about 50,000 persons. Their collection program provides for services outside their City Limits including the Village of Guadalupe. This cooperative attitude results in solid wastes disposal service to some of the dispersed population of the County.

Life expectancy of Tempe's one landfill site is estimated to be about one year. This may be extended by accelerated sand and gravel operations, but that is not certain.

It has been suggested that Tempe join with Scottsdale and Mesa in their cooperative disposal program with the Indian community. This is, at least, a reserve site to take solid wastes from that part of Tempe lying north of U.S. Highway 60-70-80. It may prove to be feasible as a long-term plan.

Tempe, like Phoenix, has an adequate current disposal program but controls no other disposal sites. Tempe's long-term disposal program is inadequate and must be developed soon. Recommendations in Section 6 of this Report include a general plan upon which detailed planning and action may be based.

SCOTTSDALE AND MESA AREA PROGRAM: The disposal site operated by the Salt River-Pima-Maricopa Community Tribal Council is improving markedly in 1968. It is expected to attain sanitary landfill status in February. This site provides the basis for long-term planning of a mutually beneficial joint venture between the Indian community, the County, and the Cities of Scottsdale and Mesa. It is also a site for Tempe to consider.

This site is on Indian Reservation land. It has a different legal status from most other disposal sites in the County in that the principal hauling agencies are neither site owners nor operators. The amount of land area actually reserved from other uses and for sanitary landfill was not reported. However, existing rough terrain along the Salt River extends from the present site southwesterly between Scottsdale and Mesa toward Tempe. This strip is about three miles long and may provide opportunity to mine gravel, dispose of solid wastes, improve the land, and progressively reduce haul distances.

The present site provides disposal service to a population of about 115,000 persons. This is an adequate basis for efficient sanitary landfill operations. The County and cities benefit from lower disposal costs than each could achieve independently. The Indian community benefits from land rental, land improvement, and creation of some skilled jobs on the reservation.

A land use plan for this site has not been reported. Combined solid wastes tonnage from Mesa and Scottsdale is expected to average 400 tons per day in the 1970-1980 decade. To prepare for an operation of this magnitude it appears logical to install a scale house, accumulate accurate weight records, make surveys of compacted wastes in the fill, relate tonnages to sources of wastes, and prepare a feasible, detailed plan of operations for efficiency and for ultimate land use.

CHANDLER-GILBERT AREA PROGRAM: The Chandler-Gilbert-County disposal program has been reorganized in 1967. An engineering study of the existing disposal site resulted in a program extending the landfill life an estimated ten years. Prior to the site study it had appeared that this site's remaining life was a few months. Now there is adequate time for careful study of the long-range problems. Planning and budgeting can now proceed logically to a long-range program.

TOLLESON AREA: Tolleson operates a dump near the Salt River and 91st Avenue. Tolleson's disposal tonnage rate and disposal costs were not reported. At an estimated 3.5 pounds per capita per day about 9 tons per day is the estimated current disposal rate. This is not an adequate tonnage basis to operate an efficient sanitary landfill.

Two current alternates may be considered in the interests of establishing sanitary landfill for Tolleson quickly:

Alternate A. Tolleson could benefit by joining the Glendale area disposal program. Disposal costs would be based on population served at about $0.10 per person per month. Disposal cost would be about $500.00 per month. Haul would increase from 8 miles round trip to 18 miles round trip, a difference of 10 miles. Tolleson's disposal rate is estimated at 270 tons per month. The increase in haul cost is estimated at $320.00 per month as compared to present haul. The monthly cost increase is estimated to be $820.00 less Tolleson's present disposal cost.

Alternate B. Tolleson could consider joining with Avondale, Goodyear, and Litchfield Park in operating a sanitary landfill. Haul cost for 6 additional miles is estimated to cost $160.00 per month additional as compared to present practice. Disposal cost is estimated at $2.80 per ton at the low tonnage base. Monthly disposal cost is estimated to be

$750.00. Haul and disposal estimated monthly costs would be $910.00 less present disposal cost.

Alternates A and B above are intended as interim alternates to the current open dump operation and would not preclude another long-term program.

AVONDALE-GOODYEAR-COUNTY AREA PROGRAM: About 11,000 people are served by the Avondale-Goodyear landfill. In lieu of factual data, which was not reported, tonnage to this landfill is estimated at 3.5 pounds per capita per day. Daily tonnage is estimated to be about 20 tons. This is not an adequate base for operating a sanitary landfill efficiently.

Alternate B for Tolleson considered combining their 9 tons per day with this 20 tons per day. That would provide an estimated $750.00 per month revenue to help this operation.

Other long-term alternate programs are considered in Section 6 of this Report.

Haul costs for Avondale, Goodyear, and Litchfield Park would not be affected. Their disposal unit cost for sanitary landfill is estimated to be $2.80 per ton. Present disposal unit costs for landfill were not reported.

BUCKEYE AREA PROGRAM: Buckeye uses a burning, surface dump. Tonnage and cost records were not reported for Buckeye. Disposal cost is estimated to be negligible. Round trip haul distance is 4 miles. Estimated daily tonnage from about 2,000 people is 3.5 tons. Haul cost is estimated to be $1.40 per ton and $150.00 per month. The tonnage rate precludes establishing an efficient sanitary landfill on a one-community basis.

It is a 34-mile round trip to the nearest disposal site at Avondale. A one-man haul is estimated to cost $400.00 per month. Disposal at $2.80 per ton is estimated to cost $300.00 per month. Haul and disposal cost is estimated to be $700.00 per month and $550.00 per month more than present operations. Based on those estimates the unit cost would be $6.70 per ton for haul and disposal.

GILA BEND-COUNTY AREA PROGRAM: Gila Bend and vicinity uses a trench landfill operated by the County. Earth cover is scheduled twice weekly. Combustible wastes are commonly burned in and adjacent to the trench. Tonnage and cost data were not reported by Gila Bend. Production of solid wastes in Gila Bend is estimated to be 3.5 tons per day. Municipal collection is incomplete. Some commercial wastes are hauled to the disposal site by private vehicles. Promiscuous dumping is common in the desert land around Gila Bend.

The Palo Verde landfill, operated by the County, is the nearest one that Gila Bend might use now in a regional program. But the round trip haul would be at prohibitive cost. Alternate regional programs for Gila Bend's long-term needs are considered in Section 6 of this Report.

WICKENBURG AREA PROGRAM: Wickenburg, like Gila Bend, is located too far from other disposal sites to join a regional program at reasonable cost. The present burning dump is located in a rocky canyon about 2 miles southwest of the community. Cover material from this site has all been used. Burning reduces the volume of solid wastes, and tin cans are recovered manually by raking through the ashes. Smoke from the site drifts back over the community.

The Town of Wickenburg made a one-week evaluation of collection and disposal tonnage in the summer of 1967. Forty-eight thousand seven hundred pounds were collected for an average day tonnage of 3.5 tons. This also amounts to a rate of 2.8 pounds per capita per day.

Good landfill sites are available northwest of Wickenburg at 7 miles average round trip haul distance. The haul cost would be nominal, but operation of a sanitary landfill, including daily earth cover, would be inefficient and expensive because of the low tonnage base from Wickenburg.

Eighteen thousand dollars is the approximate annual budget for collection and disposal by Wickenburg. The annual owning and operating cost is about $20,000 for one piece of equipment capable of excavating for, compacting, and covering most solid wastes collected by Wickenburg. Minimum annual total cost for a sanitary landfill is estimated to be $22,000. Wickenburg's present annual collection rate, about 1,300 tons, would represent a minimum estimated unit disposal cost of $17.00 per ton. (For the Aguila area program see Page S 6-46.)

Further consideration of alternate disposal programs for Wickenburg is included in Section 6 of this Report.

CAVE CREEK-CAREFREE-NEW RIVER AREA PROGRAM: Southwest of Cave Creek the County operates a landfill. The trench is cut in predominantly caliche soil. This site shares a small tractor-dozer with sites near Gila Bend and Palo Verde on a semi-weekly schedule. In late 1967, the Cave Creek landfill supported a large fly population. No evidence of burning was seen at that time. This area's population is not adequate to support an efficient sanitary landfill.

Round trip haul distance to the Phoenix sanitary landfill at 19th Avenue and Greenway is about 40 miles. Twelve tons per week is the estimated collection rate from Carefree and Cave Creek. Based on hauling 4 tons every other day to the 19th Avenue landfill, the daily haul cost is estimated to be $10.00. The estimated unit haul cost is $2.50 per ton. Five dollars is the established disposal cost for Phoenix Class I wastes in trucks over 3 tons at the Phoenix sanitary landfills. Therefore, the unit disposal cost would be $1.25 per ton; estimated unit haul cost $2.50 per ton; and estimated unit haul and disposal cost $3.75 per ton.

HASSAYAMPA VALLEY AREA PROGRAM: The County's landfill near Palo Verde serves an undetermined dispersed population. A trench on a 40-acre site is serviced on a semi-weekly schedule by the tractor-dozer shared with Cave Creek and Gila Bend landfills. No records of tonnage or costs were reported. Alternate means of serving dispersed areas are considered in Section 6 of this Report.

ADEQUACY OF EXISTING LAWS AND REGULATIONS

GENERAL: Some existing laws of the State of Arizona are considered in this subsection as they relate to future solid wastes disposal programs. Rules and Regulations of the Arizona State Department of Health and of the Maricopa County Health Department are reproduced for reference. Selected municipal regulations are also reproduced for reference.

To determine relations between laws and engineering programs and to judge adequacy of existing laws required consultation between attorneys at law and John Carollo Engineers.

LEGAL OPINIONS ON STATE LAWS: After consultations with Mr. L. LaMar Shelley (Johnson Shelley Roberts & Riggs), Mr. Shelley reported as follows:

> "You have asked for an opinion from me with respect to the following two questions:
>
> (1) Is an Amendment of Sections 9-441 and 9-442, Arizona Revised Statutes, necessary to permit a city, town or county to acquire the land for and operate and maintain a sanitary land fill operation for disposal of garbage and trash at a location to be determined by the governing body of such public entity?
>
> ANSWER: No.
>
> (2) Is there specific statutory authority for a city or town to conduct a sanitary land fill operation?
>
> ANSWER: Yes.
>
> "At the present time, Sections 9-441 and 9-442, Arizona Revised Statutes, reads as follows:
>
> '9-441. Special areas for dumping grounds; location
>
> A. Special areas to be used by the public for dumping and despositing rubbish, refuse, debris and trash shall be provided by the governing body of each incorporated city or town, or the board of supervisors for each unincorporated city or town. Such areas shall be known as public dumping grounds and shall be located at such intervals and as conveniently as the governing body or board deems necessary, but in no case within one mile of an incorporated city, town or residential area, nor within one quarter of a mile of a federal or state highway, park, recreational area or monument.

> B. If a county or incorporated city or town does not own land suitable for the purpose of this section, the board of supervisors of the county, or the governing body of the city or town, shall purchase, lease or otherwise acquire control of sufficient property for the dumping grounds.
>
> 9-442. Unlawful dumping, penalty
>
> Any person who dumps, deposits, places, throws or leaves refuse, rubbish, debris, trash, filthy or odoriferous objects or substances, except fertilizer, upon any land, lot or property, public or private, except on such public dumping grounds as are now or hereafter provided, is guilty of a misdemeanor.'

"In arriving at the meaning of the foregoing provisions, the Legislative history is helpful. In 1919 a bill was passed which became Chapter 47 of the Session Laws of Arizona, 1919, found on page 54. This act made it unlawful to deposit rubbish and like items any place in the state within one mile of the limit lines of an incorporated town, village or city of the state. That act was condensed and revised, and in part became Section 4715, Revised Code of Arizona, 1928, which read as follows:

> 'Section 4715. Depositing Filth or Rubbish Near Town Limits; Penalty
>
> Any person who places or deposits any rubbish, debris, filthy or odoriferous objects or substances upon or along any highway, vacant land, lot or premises, within one mile of an incorporated town or city of the state is guilty of a misdemeanor.'

"In 1939, House Bill No. 178 was passed and became known as Chapter 55 of the Session Laws of Arizona, 1939. That bill was almost exactly the same as our present Sections 9-441 and 9-442, and in addition to the above wording specifically repealed Section 4715, Revised Code of 1928.

"Thus, in 1939 when House Bill No. 178 was introduced, there was then in existence a law that made it a misdemeanor to place or deposit any rubbish, debris, filthy or odoriferous objects or substances upon or along any highway, vacant land, lot or premises within one mile of an incorporated town or city of the state. Apparently the Legislature wanted a place provided that could be used by the public as an open dump and made a requirement that there be special areas to be used by the public for dumping and depositing such items with the limitation noted in Section 9-441 on location.

"What Section 9-441 requires is that there be special areas provided by the city, town or county, as the case may be, for the general public to use in dumping rubbish, trash, etc. The type of area contemplated by the Legislature is a location where such items can be dumped on top of the ground and left. There is nothing in Section 9-441 which prohibits a city, town or county from making provision for garbage disposal to be used by the town, city or county itself, nor does Section 9-442 make it a misdemeanor for a city, town or county to dispose of garbage and trash in places other than the open dumps contemplated in Section 9-441. That Section 9-442, referring to unlawful dumping, does not apply to a city, town or county, is made plain by the provisions of Sub-Section 21 of Section 1-215, Arizona Revised Statutes, which reads as follows:

> '21. "Person" includes a corporation, company, partnership, firm, association or society, as well as a natural person. When the word "person" is used to designate the party whose property may be the subject of a criminal or public offense, the term includes the United States, this state, or any territory, state or country, or any political subdivision of this state which may lawfully own any property, or a public or private corporation, or partnership or association. When the word "person" is used to designate the violator or offender of any law, it includes corporation, partnership or any association of persons.'

"Here when the word person is used to indicate the violator or offender of any law, it includes only a corporation, partnership or any association of persons, which specifically excludes a public entity. Therefore, nothing contained in Sections 9-441 and 9-442 prohibits a city, town or county from operating and maintaining garbage disposal areas for garbage collected by them where they choose.

"There has been no decision of either of the courts of appeal or our Supreme Court interpreting the above sections in the above manner. The only case involving them that I am aware of arose in Tucson and was entitled, Federal Development Corporation -vs- Stefan Gollob. Apparently, the City of Tucson was involved in the action. The case number is 83149. There the court ruled in its minute entry as follows:

> '1. That a nuisance per se did not exist. The location is an area prohibited by 9-441 and 9-442, A.R.S. The operation conducted at the location constituted a "land fill operation" rather than an "open dump". In considering the effect of construction of statutes by administrative officers as set out in Conway vs. Mosher, 55 Ariz 467, State -vs- Davenport, 61 Ariz. 355, and Albord vs. State Tax Commission,

> 69 Ariz. 287; and further considering the Rules and Regulations of the Arizona State Department of Health, the Court finds that a "land fill operation" is not within the prohibition of said statutes.'

"It is my opinion that nothing contained in Section 9-441 above quoted refers to or attempts to regulate the location of a sanitary land fill operation operated by a county, city or town.

"Our present Section 9-521 and Section 9-522, Arizona Revised Statutes, specifically authorize cities and towns to construct, improve, reconstruct, extend, operate, maintain and to acquire by gift, purchase or the exercise of the right of eminent demain, the necessary land for a garbage or rubbish plant or system including but not limited to disposal, treatment or reduction plants, buildings and incinerators. Since this provision is contained in the section of the code referring to revenue bonds for financing utilities, a brief resume of the history and provisions of this act is included.

"It appears that the first revenue bond act was passed in the first special session of the 14th Legislature in 1940, and in that act the only utility undertaking defined was a water works. This was amended in 1941 by Chapter 107 of the 1940 Session Laws. That act defined utility undertaking as follows:

> ' "Utility Undertaking" means any one or combination of the following:
>
> Electric light or power, water, sewer, gas, garbage, or rubbish plant or system, together with all parts thereof and appurtenances thereto, including, but not limited to disposal, treatment and reduction plants, buildings, incinerators, dams and reservoirs.'

"In 1943, both of the above enactments were repealed by House Bill No. 149, which became Chapter 31 of the 1943 Session Laws found on page 72. There were some new provisions in the bill, but it changed the definition of a utility undertaking very little. In 1952 there was another amendment by Senate Bill No. 67, which became Chapter 145 of the 1952 Session Laws, and is found on page 33. Here the definition of utility undertaking was changed by inserting common carrier of passengers. There was also an amendment in 1947, which is Sub-Section 4 (b) of the present Section 9-521.

"It is noted that House Bill No. 149 above referred to contained a provision specifically repealing the previous revenue bond bills referred to, and also stating that the repeal section does not negative an implied repeal of any statute which conflicts with it. Therefore, it is plain that by the provisions of our present Sections 9-521 and 9-522, a city or town has the right to conduct a sanitary land fill operation within or without its corporate limits at a location it determines. (Underscore added.) This provision does not appear to conflict with the provisions of Section 9-441 and Section 9-442, but should there be any conflict, then because of the wording in the repeal section of the 1943 Enactment, the provisions of Section 9-441 and Section 9-442 would be repealed to the extent of the conflict. Even though the authority to acquire the property for and operate and maintain a garbage or rubbish disposal plant or system is found under the Municipal Bond for Financing Utility Section, such authority is available whether bonds are issued for financing or not. This was decided in the case of City of Scottsdale -vs- Municipal Court of Tempe, 90 Ariz 393, 396; 368 P2d 637. There the court states the rule as follows:

> 'It is first Tempe's position that Scottsdale has not been delegated the authority or power by the Legislature to construct a sewage disposal plant and it is argued that statutes which might seem applicable do not grant the right. We do not think the pertinent statutes can be so circumscribed.
>
> A. R. S. Section 9-522 provides:
>
> A. In addition to its other powers, a municipality may:
>
>> 1. * * * within or without its corporate limits, construct, improve, reconstruct, extend, operate, maintain and acquire, by gift, purchase or the exercise of the right of eminent domain, a utility undertaking * * *. (Emphasis supplied)
>
> The preceding Section 9-521 defines utility undertaking to include sewage disposal plant.
>
> (3, 4) The title to Article III of Chapter 5, under which the quoted section is found reads: "Municipal Bonds for Financing Utilities" but we think this is of no particular significance and that it does not create a limitation on the constructing of sewage disposal plants from the proceeds of bond funds. Only when the body of an act is ambiguous will courts take into consideration the title. Garrison v. Luke, 52 Ariz 50, 78 P2d 1120. There is no ambiguity here. The power to acquire property by purchase or eminent domain for utility undertakings is absolutely and unconditionally prescribed by the express language used.'

"It follows that if a city can operate a garbage or rubbish disposal plant or system for the benefit of its residents, that it can also collect or make provision for collecting such garbage or rubbish. Therefore, it would not violate Section 9-442 for the city or town to make provisions other than that found in Section 9-441, for the disposal of garbage by the public. This is sometimes done by private contractors hauling the garbage; in some instances the city or town operates the business itself; in many places now a city or town has receptacles placed at suitable locations for the public to use to dump garbage and trash in. None of these are contrary to law.

"The authority for a county to operate a sanitary land fill isn't as plain as for cities and towns, and some specific enactment of the Legislature might be helpful. However, there appears to be sufficient authority under the following to imply the power to maintain a sanitary land fill operation. Section 11-251, Sub-Section 17, and 30, read as follows:

> '17. Adopt provisions necessary to preserve the health of the county, and provide for the expenses thereof.
>
> '30. Make and enforce all local, police, sanitary and other regulations not in conflict with general law. As amended Laws 1963, Chapter 37, Section 1; Laws 1965, Chapter 96, Section 1.'

"Certainly the appropriate disposal of garbage in an approved manner is necessary to preserve the health of the county. With the urbanization of Maricopa County, it is no longer feasible to provide open dump areas and under present circumstances, operations such as sanitary land fills are required.

"While the provisions of Section 9-441 do not apply to the location of a sanitary land fill operation, care should be taken by the governing body in choosing an appropriate site. Under some circumstances, it is possible that such an operation could be considered a nuisance."

ARIZONA STATE DEPARTMENT OF HEALTH REGULATIONS

"SECTION IV REFUSE DISPOSAL

REGULATION 1. GENERAL CONSIDERATIONS

a. All refuse shall be disposed of by a method or methods included in these regulations and shall include rodent, insect, and nuisance control at the place or places of disposal. Approval must be obtained from the Department for all new disposal sites and any change in the method of disposal prior to use.

b. Carcasses of large dead animals shall be buried or cremated, unless satisfactory arrangements have been made for disposal by rendering or other approved methods.

c. All public 'dumping grounds', provided in compliance with

ARS 9-441, shall be maintained and operated in accordance with the requirements of these regulations.

REGULATION 2. METHODS OF DISPOSAL

Approval must be obtained from the Department for any method or methods used for the disposal of refuse prior to the start of operations, and shall be accomplished by one or more of the methods listed below:

a. Sanitary Landfill - Consists of the disposal of refuse on land and the daily compaction and covering of the refuse with 6 to 12 inches of earth so as to prevent a health hazard or nuisance. The final compacted earth cover shall be a minimum of 2 feet in depth. Where sanitary landfill operations are proposed, the Department will require the following:

1. The landfill shall be located so that seepage will not create a health hazard, nuisance, or cause pollution of any watercourse or water bearing strata.
2. Adequate and proper surface drainage shall be provided to prevent ponding or erosion by rainwater of the finished fill.
3. Provision shall be made for the control of insects, rodents, wind blown refuse, and accidental fire.
4. Burning of refuse is prohibited.
5. An all weather access road is required.
6. Suitable equipment and operating personnel shall be provided.
7. Salvaging, if permitted, shall be rigidly controlled.

b. Incineration - Where incineration is to be employed, the plans and specifications, along with any other information necessary to evaluate the project, shall be submitted to the Department and approval received prior to construction. In addition, an approved method for the disposal of noncombustible refuse is required. Where incineration is proposed, the following items shall be provided:

1. The capacity of the incinerator shall be sufficient for the maximum production of refuse expected.
2. Noncombustible refuse shall be disposed of by methods approved by the Department.
3. Skilled personnel to assure the proper operation

and maintenance of the facilities in a nuisance-free manner.

c. Composting - This method of disposal is acceptable to the Department under the following conditions:

1. That plans and specifications and other information necessary to evaluate the project are submitted to the Department and approval received prior to start of construction.
2. That provisions are made for the proper disposal of all refuse not considered suitable for composting.
3. Skilled personnel shall be provided to assure the proper operation and maintenance of the facilities in a nuisance-free manner.

d. Garbage Grinding - This method, involving the separate collection and disposal of garbage into a community sewerage system through commercial type grinders or mandatory community-wide installation of individual household grinders, will be acceptable to the Department provided that suitable means shall be provided for the disposal of all remaining refuse.

e. Hog Feeding - This method of disposal will only be approved under the following conditions:

1. The garbage is collected and stored in suitable containers.
2. Only approved type vehicles are used for collection.
3. All garbage is effectively heat-treated in accordance with Chapter 7, Article 3, ARS 24-941 through 949.
4. All remaining refuse, including nonedible garbage, is collected and disposed of separately by methods approved by the Department.

f. Open Dumps - This method of refuse disposal is unsatisfactory. Conditional approval for a temporary open dump may be granted only with the following provisions:

1. The dump site shall be located at a distance greater than one mile from the nearest residence or other inhabited building.
2. The dump is located so that it does not obstruct natural drainage courses or that seepage from it does not create a health hazard or nuisance in any watercourse or water-bearing strata.

3. That where salvaging is permitted, it is strictly controlled.

4. Open dump sites shall be so located or fenced to prevent blowing of dump refuse.

5. Insect and rodent control measures shall be provided. The methods and frequency shall be determined by the local health department.

6. Where controlled burning is allowed, it shall meet the requirements of the local health department.

7. Where the Department determines that such temporary open dump is no longer satisfactory, other methods of disposal shall be used.

g. Manure Disposal - Manure shall be disposed of by sanitary landfill, composting, incineration, or used as fertilizer in such a manner as not to create insect breeding or a nuisance."

MARICOPA COUNTY HEALTH CODE REGULATIONS

Excerpts: Chapter II, Sections 4 & 5, Maricopa County Health Code, Sewage and Wastes:

"CHAPTER II SEWAGE AND WASTES

SECTION 4 REFUSE DISPOSAL

REGULATION 1. General Considerations

a. No garbage, rubbish or refuse shall be placed or deposited on any alley, street, road, roadside, in any ditch, river, stream, lake, pond, canal, or on the banks thereof; or in any gulch, ravine, excavation or other place where it may be or become a public health nuisance. This regulation shall not be construed to interfere with the approved placement of garbage, rubbish or refuse for collection purposes.

b. The disposal of large dead animals shall be by burial, cremation or rendering in an approved manner, or by other approved method.

c. Garbage Grinding. The use of garbage grinders and the grinding of garbage for disposal into a community sewerage system is prohibited excepting where the owner and operator of such sewerage system declares that ground garbage is acceptable, and then only in such manner and of such type and quantity as will not have a deleterious effect on the sewage disposal process.

d. Hog Feeding. The disposal of garbage by hog feeding is prohibited unless all refuse, rubbish, and garbage attendant on the use of this method is stored, collected, transported and disposed of in compliance with the regulations in this code and applicable State Law.

REGULATION 2. Incineration

No person shall dispose of refuse using incineration excepting in compliance with the pertinent rules and regulations of this Sanitary Code and the Maricopa County Air Pollution Control Regulations.

REGULATION 3. Composting

No person shall operate a composting establishment without a valid permit therefor.

a. Plans, specifications, and other information pertinent to the project shall be submitted to the Department for review and approval prior to the start of the project and on construction work shall commence until such approval has been obtained.

b. Personnel skilled in the composting process shall be employed and used to assure the proper operation and maintenance of the facilities.

c. The handling, storage, transportation and disposal of all refuse received by the facility and of the final compost shall be performed in full compliance with this Code.

REGULATION 4. Dumps, Sanitary Landfill

No person shall conduct, operate or maintain a sanitary landfill without a permit therefor or otherwise than in compliance with the regulations of this code and of the State Department of Health.

a. Permit applications shall be made on forms supplied by the Department and shall be accompanied by acceptable copies of plans showing the location, proposed extent and the type of landfill planned, local topography, proposed final elevations and contours, access roads, proximity to built-up areas, drainage courses, and additional data as may be required by the Department to make clear the nature and scope of the work contemplated.

b. The operator of a sanitary landfill shall:

(1) Make a survey to permit accurate planning for access

roads, proper drainage, lift heights, diversion channels, dikes or levees, and to determine soil characteristics.

(2) Build a semi-permanent, all-weather road on the site, and where required, a vehicle turn-around to facilitate the orderly movement of vehicles and disposal of refuse.

(3) Assure an adequate access road to the site.

(4) Take all necessary measures to prevent refuse from being windblown.

(5) As needed, clear trees, divert springs or brooks, and remove and store top soil for cover material or procure an adequate supply of cover material.

(6) Take all measures necessary to:

  (a) prevent or eliminate the breeding or harborage of flies, mosquitoes, other insects of public health importance, rodents or other vermin;

  (b) prevent air pollution by dust, smoke, fumes, odor or from other causes;

  (c) preclude the pollution of surface or ground waters;

  (d) preclude or eliminate any public health nuisance on the premises.

c. Supervision. General supervision of the landfill and its operation shall be provided and maintained by a person familiar with the operation of landfills. Such supervision shall extend over the physical limits of the project, including access roads.

d. Face of Fill. The working face of the fill shall be kept as narrow as is consistent with proper operation of vehicles and equipment in order that the area of waste material exposed during the operating day be minimal.

e. Depth. Waste materials may be ground and shall be mechanically compacted after depositing and before covering, and shall not exceed an average depth of eight feet after initial compacting; except that deeper fills may be maintained in stages or levels.

f. Preliminary Cover. The exposed working surface shall be covered whenever feasible, with clean earth as promptly as is consistent with proper operation. At the close of each day's operations both the surface and side slopes of the fill shall be completely covered to a depth of at least 6 inches.

g. **Bulky Material.** Bulky materials, such as building rubble and tree stumps shall not be used for final surfaces or side slopes.

h. **Final Cover.** The final cover for surface and side slopes shall be maintained at a minimum depth of 30 inches.

i. **Equipment.** Sufficient standby equipment shall be provided to prevent delay in compacting and covering due to emergencies, peak loads, or for other reasons.

j. **Toe.** Where a finished fill has a boundary side slope, the toe of the slope shall terminate in a filled ditch or other structure, designed to prevent ravelling of the toe and slope.

k. **Fires.** All reasonable measures shall be taken to prevent and control fires at the landfill; and all burning is prohibited.

l. **Maintenance.** After the active period of filling operations is completed, a maintenance program shall be continued so as to insure prompt repair of cracks, depressions, surface and side slope erosion until the fill has become stabilized.

m. **Scavengers.** The operator of the landfill shall be responsible for compliance with these regulations by scavengers where tolerated, and for their supervision.

n. **Special Wastes.** The disposal of human excreta from septic tanks, cesspools, job toilets, and similar sources, and of dangerous liquids or solids such as solvents, pesticides or other poisons and their containers shall be conducted only with the special approval of the Department and only in an approved manner.

CHAPTER II SEWAGE AND WASTES

SECTION 5 REFUSE COLLECTION AND DISPOSAL SERVICES

REGULATION 1. Permits

No person shall collect, haul, remove or dispose of refuse for hire, fee or other consideration without a valid permit to do so.

REGULATION 2. Vehicles

a. Vehicles used for the collection and transportation of refuse shall have securely covered watertight bodies of easily cleanable construction, shall be cleaned frequently enough to prevent their becoming a public health nuisance, and shall be maintained in good repair. Refuse storage compartments therein shall not be open or exposed excepting for filling, emptying and cleaning.

b. Vehicles shall be loaded and moved in such a manner that the contents are not unnecessarily exposed at any time, and do not fall, leak, or spill therefrom; and where spillage does occur, it shall be picked up immediately by the permittee and returned to the vehicle or otherwise removed in a sanitary manner.

c. Each vehicle operated under permit shall have the permit number clearly inscribed on the side door panels and rear face thereof in letters or numerals or both which are clearly visible.

REGULATION 3. Emptying

The permittee shall empty all refuse storage containers completely during the collection operation.

REGULATION 4. Disposal

The permittee shall dispose of all refuse by an approved method and at an approved site. Such approval must be obtained in advance of the commencement of operations and prior to any change of method or site."

MUNICIPAL REGULATIONS

CITY OF CHANDLER, TOWN OF GILBERT, AND MARICOPA COUNTY:

"OPERATING REGULATIONS AND FEE SCHEDULE SANITARY LANDFILL

In accordance with the terms of the agreement entered into by Maricopa County, Town of Gilbert and City of Chandler for the joint use and operation of a sanitary landfill, the following fee schedule and rules shall govern disposal of waste materials at this sanitary landfill site:

Section 1. All persons, firms, corporations, or governmental agencies engaged in dumping from areas within the corporate limits of the Town of Gilbert and City of Chandler and in the immediately surrounding unincorporated area in Maricopa County shall be permitted to dump in an area designated by Maricopa County, Town of Gilbert, and City of Chandler as a public sanitary landfill project payment of the applicable dumping fee and subject to the operating rules and regulations established herein. Householders shall be permitted to dump Class 1 refuse free of charge in accordance with fee schedule on Class 1 refuse. Business firms in the incorporated area may dump without charge materials which their municipal refuse removal service would handle, if they subscribe to the municipal service. However, to qualify for this free dumping privilege, the business firm must obtain prior clearance from the Chandler City Manager who serves as the managing representative for the three cooperating agencies.

Section 2. For the purpose of establishing an assessment base for the fee schedule, refuse shall be divided into three classes, hereinafter referred to as Class 1, Class 2, and Class 3.

> Class 1 refuse shall include all loose, easily compactible matter of a unit size which can be moved readily or handled by machinery or equipment normally used in operation of a landfill project; for example, household garbage and light trash including trimmings and grass clippings.
>
> Class 2 refuse shall include trees, logs, stumps, construction wastes, motor vehicle bodies or parts or any other items of refuse of a unit size or weight such as to be difficult and costly to move, handle or compact by normal landfill operation. Trees, logs and stumps must be trimmed of brush and cut into pieces not exceeding six feet in length.
>
> Class 3 refuse shall consist of cesspool pumpings and similar liquid waste, but not including insecticides, poisons, inflammables, or dangerous industrial wastes.

Section 3. All persons, firms, corporations or governmental agencies dumping in this sanitary landfill shall pay the applicable fee for each dumping unless arrangements for monthly payment have been made with the City Clerk, City of Chandler, 98 West Chicago Street.

Section 4. The fees for each dumping shall be assessed according to the following schedule:

For Class 1 refuse: The fees shall be based upon the type of vehicle used in delivering refuse for dumping as follows:

1. Auto, station wagon, jeep, 1/2 ton pickup truck dumping from an individual household, but not a business except as provided in Section 1 above.	NO CHARGE
2. 1/2 ton operating for hire, 3/4 ton to 1 ton pickup truck, or two wheel trailer	$ .50
3. 1-1/2 ton to 3 ton trucks, or 4 wheel trailers	2.00

4. Trucks or trailers 3 tons to 5 tons	$ 5.00
5. Trucks or trailer over 5 tons	10.00

For Class 2 refuse: No log, tree or stump in excess of 18 inches in diameter or six feet in length, nor any construction refuse or demolished building materials which are too large pieces for the landfill equipment to handle readily shall be accepted for dumping. The dumping fees shall be based upon the size, quantity and nature of the refuse material and the unit size as follows:

1. Logs, trees or stumps; loads containing one to three units, less than 18 inches in diameter, but more than 12 inches in diameter, per load, $15.00. If more than three such units, the charge shall be $5.00 for each such unit in excess of three units with a maximum charge of $25.00 per load.

2. Logs, trees or stumps, loads containing one to six units, less than 12 inches in diameter but more than 6 inches in diameter, per load, $10.00. If more than six such units, the charge shall be $2.00 for each such unit in excess of six units with a maximum charge of $20.00 per load.

3. Logs, trees or stumps, each load containing no unit more than six inches in diameter, the charge shall be the same as for Class 1 refuse, but each such log, tree or stump shall be trimmed of brush or roots.

4. The diameter of the largest unit of logs, trees or stumps in each load of Class 2 refuse shall be used in determining the fees to be charged as described in paragraphs 1 through 3 above.

5. For construction waste materials, the fees shall be based upon the type of vehicle and shall be the same as for Class 1 refuse.

6. Other items of refuse in Class 2 such as motor vehicle bodies or parts, washing machines, coolers, refrigerators or items of extraordinary unit size or weight not normally disposed of by landfill methods, the charge shall be $10.00.

For Class 3 refuse: Each dumping of a cesspool pump truck, whether filled to capacity or not. $1.00

Section 5. Upon payment of the applicable fees, franchised haulers of garbage (Class 1 refuse) from the unincorporated area of Maricopa County immediately surrounding the landfill site shall be permitted to dump up to 40 cubic yards of refuse per operating day which is proportionate to the refuse load from the other joint operators of this sanitary landfill according to the population ratio used in distributing the costs to the participants in this joint venture. The full rated capacity of the vehicle dumping will be used in maintaining the record of amount dumped daily. In addition such franchised haulers may dump one load per operating day of Class 2 refuse from a truck ranging in capacity up to and including 3 tons. There will be no carry-over from one day to the next of unused dumping allowances.

Section 6. Because of the inability to predict all types of refuse that might be presented for disposal, the right to refuse dumping privileges, in the best interest of operating and prolonging the life of the landfill, is reserved. Further, the right is reserved to amend these operational regulations and fee schedule as required for the efficient economical and safe operation of the sanitary landfill subject only to the approval of the representatives of the three participating jurisdictions.

Approved by Maricopa County, Town of Gilbert, and
City of Chandler this 11th day of July 1961."

CITY OF TEMPE:

"Ordinances 432 and 432-1, Section 8, Paragraph E:

E. Residents of the City may, upon proof of such residency, deposit in the Sanitary Land Fill of the City of Tempe, without charge, garbage or refuse accumulating on their own residential premises if the same is not a by-product of any commercial or industrial venture. A business or industrial user may deposit wastes from such use in the Sanitary Land Fill of the City of Tempe if the same waste has been the result of operations within the City Limits of the City of Tempe, except that a charge will be made for each load at One ($1.00) Dollar per cubic yard or a fraction thereof up to and including four (4) cubic yards, plus Fifty ($0.50) Cents per cubic yard or fraction thereof in excess of four (4) cubic yards. All persons depositing garbage or trash in the Tempe Sanitary Land Fill must do so in the place and manner as may be established by the City."

CITY OF PHOENIX:

"CITY OF PHOENIX CODE, Chapter 22, Article II

SEC. 22 - 23. All persons or governmental agencies engaged in dumping at any city sanitary landfill project from areas within and beyond the city shall be permitted to dump in an area designated by the city as a public sanitary landfill project upon payment of a dumping fee or upon payment of an annual license fee subject to the conditions of this article.

SEC. 22 - 24. For the purpose of establishing an assessment base, refuse shall be divided into three classes, referred to in this article as Class 1, Class 2 and Class 3.

Class 1 refuse shall include all loose, easily compactible matter of a unit size which can be moved readily or handled by machinery or equipment normally used in operation of a landfill project.

Class 2 refuse shall include trees, logs, stumps, construction wastes, motor vehicle bodies or parts or any other items of refuse of a unit size or weight such as to be difficult and costly to move, handle or compact by normal landfill project operation. Trees, logs and stumps must be trimmed of brush and cut into pieces not exceeding eight feet in length.

Class 3 refuse shall include fluid or solid waste pumped or otherwise extracted from a septic tank, cesspool, chemical toilet, sewage seepage pit, privy, grease trap or sand trap. Disposal of Class 3 refuse at a city sanitary landfill shall be prohibited except when done in conformance with the Sanitary Code of the county health department.

In addition to county health department regulations governing vehicle and auxiliary equipment used in the transportation and dumping of Class 3 refuse, the city reserves the right to impose regulations governing size and location of emptying valves and other devices involved in transporting and dumping of Class 3 refuse.

SEC. 22 - 25. All persons or governmental agencies engaged in dumping Class 1 refuse, as described in section 22 - 24, at any city sanitary landfill project from areas within the city shall be permitted to dump upon payment of a fee for each dumping or upon payment of an annual license fee.

All persons or governmental agencies engaged in dumping Class 1 refuse at any city sanitary landfill project from areas beyond the city shall be permitted to dump upon payment of a fee for each dumping.

All persons or governmental agencies engaged in dumping

Class 2 and Class 3 refuse at any city sanitary landfill project from areas within and beyond the city shall be permitted to dump upon the payment of a dumping fee for each dumping.

SEC. 22 - 26. The fees levied by this section shall be assessed for each dumping as follows:

(a) For Class 1 refuse, the fees shall be based upon the type of vehicle designated for the purpose of dumping at the landfill project as follows:

1.	Private passenger car, jeep, station wagon, 1/4 ton pickup trucks	$0.00
2.	1/2 Ton to 1 ton pickup truck, or two-wheel trailer	0.00
3.	1-1/2 Ton to 3 ton trucks or 4-wheel trailers	2.50
4.	Trucks or trailers over 3 tons	5.00

(b) For Class 2 refuse, the dumping fees shall be based upon the size, quantity and nature of the refuse material and the unit size as follows:

1.	Logs, trees or stumps, loads containing one unit to three units, 30 inches or more in diameter, per load.	$20.00
	If more than three such units, the charges shall be for each such unit in excess of three units with a maximum charge of $25.00 per load.	5.00
2.	Logs, trees or stumps, loads containing one unit to three units, less than 30 inches in diameter, but more than 18 inches in diameter per load.	15.00
	If more than three such units, the charge shall be for each such unit in excess of three units with a maximum charge of $25.00 per load.	5.00
3.	Logs, trees or stumps, loads containing one unit to six units, less than 18 inches in diameter but more than 12 inches in diameter, per load.	10.00
	If more than six such units, the charge shall be $2.00 for each such unit in excess of six units with a maximum charge of $20.00 per load.	
4.	Logs, trees, or stumps each load containing	

no unit more than twelve inches in diameter, the charge shall be the same for Class 1 refuse, but each such log, tree or stump shall be trimmed of brush and cut into pieces not exceeding eight feet in length as provided in section 22 - 24.

5. The diameter of the largest unit of logs, trees, or stumps in each load of Class 2 refuse shall be used in determining the fees described in paragraphs 1 through 4 of this subsection.

6. For construction waste materials, the fees shall be based upon the type of vehicle and shall be the same as for Class 1 refuse.

7. Other items of refuse in Class 2 such as motor vehicle bodies or parts or items of extraordinary unit size or weight not normally disposable by landfill methods, the charge shall be $20.00 per unit.

(c) For Class 3 refuse the dumping shall be as follows:

1. For a vehicle whose tank capacity is zero to 1500 gallons the per load fee shall be $0.75.

2. For a vehicle whose tank capacity is in excess of 1500 gallons the per load fee shall be $2.50.

SEC. 22 - 27. Annual dumping licenses may be obtained by persons or governmental agencies under conditions described in section 22 - 25, from the division of licenses, after approval by the superintendent of street maintenance or his authorized representative. The annual dumping license fee shall be forty-eight dollars payable annually for the fiscal year commencing on July first and ending on June thirtieth, however, fees may be prorated on licenses granted during the fiscal year, on the basis of charge for a full month for licenses granted before the sixteenth day of any month and no charge for the month when the license is issued after the fifteenth day of any month.

SEC. 22 - 28. Issuance of an annual dumping license shall be limited to those persons or governmental agencies who reside in or whose place of business is located within the city and those persons regularly engaged in the business of collection and removal of Class 1 refuse for other city residents or businesses. Applicants for such licenses must furnish adequate evidence to the superintendent of street maintenance, or his authorized representative, that the refuse to be dumped is from areas within the city and must only use the license for disposal of refuse collected within the city. In the case of those persons regularly engaged in the business of collection and removal of Class 1 refuse for others, they shall be required to have an active, bona fide permit to haul or remove garbage, rubbish or refuse issued by the Maricopa County health department.

If the licensee desires to change a license from one truck or trailer to another, he may apply to the division of licenses for a transfer of his license to the replacement vehicle. No refunds shall be made when a vehicle is removed from service.

Validity of a license during its term shall depend on comparison of the number of the state motor vehicle license plate attached to the vehicle to that given by the licensee at the time of issuance of the dumping license. If, during the annual term of the dumping license, a new state motor vehicle license plate is issued, the licensee shall notify the division of licenses in writing of such change.

Annual dumping licenses shall not be issued for trucks or trailers of over 3 tons capacity unless the truck or trailer is regularly, continuously and exclusively used by the applicant in the business of collection and removal of Class 1 refuse for city residents or businesses and the truck or trailer to be licensed is capable of self-dumping and complies with the Maricopa County health department Sanitary Code.

SEC. 22 - 29. The provisions of this article shall apply to all persons, firms, corporations or other governmental agencies excepting the ones otherwise covered by contractual agreements with the city. Fees for dumping refuse from city construction projects, except excess from excavation, may be waived but other conditions of this article as they apply to such refuse must be complied with.

The city manager or his designated representative is authorized to waive dumping fees on refuse from tax supported public schools on nonprofit private schools located in Phoenix or unincorporated areas of Maricopa County hauled in vehicles clearly and permanently marked as belonging to and serving such tax supported public schools or nonprofit private schools.

SEC. 22 - 30. The city reserves the right to impose reasonable operational regulations of the dumping processes such as periods of time during which dumping may take place and locations within the area which may be used at specific times.

SEC. 22 - 31. Licenses issued under the provisions of this article may be suspended or cancelled upon the failure or refusal on the part of a licensee to comply with the provisions of this article and upon the recommendation of the superintendent of street maintenance.

SECTION 6

A PLAN FOR DISPOSAL OF SOLID WASTES IN MARICOPA COUNTY

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SECTION 6

A PLAN FOR DISPOSAL OF SOLID WASTES IN MARICOPA COUNTY

GENERAL

Disposal of solid wastes in Maricopa County will be a program of increasing magnitude throughout the three decades considered in this Report. Those decades are the periods: 1970 to 1980, 1980 to 1990, and 1990 to 2000. During that thirty-year period the population of the County is expected to rise to about 3,000,000 persons.

Rate for disposal of solid wastes in the County by the year 2000 is projected to be about 7,000 tons per day from residential, commercial, and industrial sources. This rate does not include a rate for agricultural solid wastes which fluctuates seasonally and is not directly related to population. The cost of haul and disposal of solid wastes in Maricopa County would be in excess of $10,000,000 per year at $4.00 per ton. When the annual cost reaches $10,000,000 per year, a one percent increase in efficiency will amount to a saving to the residents of the County of $100,000 per year.

At 7,000 tons per day and 1,000 pounds per cubic yard in place the volume required for disposal of solid wastes in Maricopa County would be 14,000 net cubic yards per day. Annually that tonnage would occupy a space 10 feet high, 100 feet wide, and one mile long.

Haul and disposal of solid wastes in the next three decades is a complex problem which demands careful analysis, development of the best possible long-range solutions, and continuing review of operations to maintain high efficiency.

PURPOSES OF SOLID WASTES DISPOSAL PROGRAMS

Good sanitation practices tend to protect the public health. One purpose of careful solid wastes disposal is to isolate putrescible solid wastes, commonly garbage, so that contact, direct or indirect, with the public or with disease vectors is minimized. Thus garbage cans are covered; they are emptied into watertight, covered trucks; and truck loads are buried promptly and adequately after dumping at a sanitary landfill. Special wastes like explosives, poisons, infected tissues, acids, and caustics endanger public health; they demand special disposal provisions to minimize the danger.

"Solid Wastes/Disease Relationships," a literature survey by the U. S. Department of Health, Education, and Welfare, Public Health Service, is a report on present knowledge of the public health aspects of solid wastes. The Summary and Conclusion contains this paragraph:

> "The literature fails to supply data which would permit a quantitative estimate of any solid waste/disease relationship. The circumstantial and epidemiologic information presented does support a conclusion that, to some diseases, solid wastes bear a definite, if not well defined, etiologic relationship. The diseases so implicated are infectious in nature; no relationship can be substantiated for noncommunicable disease agents associated with solid wastes, not because of negating data, but because of lack of data. (An exception to this statement may exist in the instance of methemoglobinemia of infants in which nitrates of excretory origin may play a part.)"

Flies are definitely identified as disease vectors, transferring disease agents from organic wastes to humans by contact. Mosquitoes are reported as being potentially dangerous as carriers of disease agents from solid wastes to humans, but strict proof of an occurrence is lacking.

Another paragraph reads:

> "At this time, few human cases of rodent-borne zoonoses are being reported in the United States. No recent data were found bearing on the relative importance between solid wastes and other media in contributing to domestic rat populations, thus incidence of the reported zoonoses cannot be estimated in relation to solid wastes. Human plague experienced in recent years in this country seems to be totally of direct sylvatic origin. The importance of the domestic rat in the few reported cases of leptospirosis cannot be judged because of insufficient epidemiologic data. The direct origin of the leptospirae responsible for human infection were largely of bovine or other domestic animal origin. The further tracing of the organisms to rats was not accomplished (see rodent-borne disease section). Other solid waste/disease relationships must remain speculative pending far more definitive studies. Because of the low level of incidence of a number of diseases for which a relationship could be postulated, it would appear that there is little hope of obtaining data sufficient for analysis in this country, and that applicable studies would have to be made on foreign populations if a more valid comprehension of an association is to be made."

During the study leading to this Report no rat was observed at any disposal site. Gophers native to the desert were observed at most disposal sites. No human disease/rodent/garbage relationship was found in Maricopa County during the study. Fly populations were common at open dumps and landfills. Burning dumps did not support flies. Mosquito breeding was not observed and is probably not to be expected where dry sites offer no breeding areas for mosquitoes.

Thus one reason for careful disposal of solid wastes is more a concern with a probable disease relationship than with strict proof of actual wide-spread disease relationship.

A second purpose of careful solid wastes disposal is to place wastes out of sight simply because they are repugnant under our society's accepted standards.

A third purpose is to prevent the odor nuisance created by open concentrations of putrescible wastes.

A fourth purpose is to reduce the fire hazard created by accumulations of exposed combustible wastes. Fire hazards are both health hazards and threats to real property. Fires add to air pollution.

A fifth purpose is to reduce mechanical hazards created by exposed metal edges, broken glass, crumbling piles, lockable refrigerators, etc.

A sixth purpose is to concentrate solid wastes in special areas to free and preserve space in other areas.

Costs for collection, haul, and disposal are a significant financial burden, but the needs for the program are compelling.

The summation of problems related to accumulating solid wastes has a regional impact and is not confined within neighborhood or municipal boundaries. Thus the program must provide regional solutions to the regional problems.

DEFINITIONS OF REGIONAL PROBLEMS

Different classes of solid wastes require different provisions in a haul and disposal program. Extent of the program is partly determined by the classes of solid wastes to be disposed. Kinds of solid wastes may be classified according to the activity which generates the wastes:

1. Residential and institutional
2. Commercial and industrial
3. Construction and demolition
4. Traffic and recreational
5. Agricultural

These five classifications provide a general basis for determining where the corresponding wastes will accumulate, what group produced them, and what the components of each class will be.

RESIDENTIAL AND INSTITUTIONAL SOLID WASTES will normally accumulate throughout the urbanized areas. Components of those wastes will include garbage and rubbish in containers; uncontained, bulky rubbish; and heavy, large items. At least three kinds of collection equipment will be needed:

1. Closed garbage trucks for contained wastes
2. Open trucks for tree trimmings, etc
3. Loading equipment for logs and other large items

Hauling operations will originate on collection routes in urban areas, and the need for special trucking equipment will be dictated by kinds of wastes collected. Optimum disposal locations are related to source locations and relative payloads on each type of equipment.

Disposal operations will provide for efficient disposal of each load and total tonnage.

COMMERCIAL AND INDUSTRIAL SOLID WASTES do not occur distributed in proportion to the population density but rather along commercially and industrially zoned strips, blocks, and areas. As commercial and industrial density increases with time, those solid wastes will occur more uniformly distributed throughout commercial and industrial zones.

In this program haul of commercial and industrial solid wastes may continue to be by either private or public agencies or both. Nationally private hauling firms collect over half of all commercial and industrial solid wastes. The choice is largely a matter of policy to be determined by governing bodies.

First consideration is that collections be complete, timely, and sanitary thus meeting the physical problem.

Private collection firms may tend to concentrate upon the more profitable areas while neglecting the less profitable areas. Areas requiring collection service but denied collection by private firms must be served by a municipal program or be included, by franchise, in a private program.

Second consideration is the financial burden on commercial and industrial firms.

In this program disposal of solid wastes is based on municipal operations although there is no basic reason that private disposal sites could not be substituted. There should not be two nearby disposal sites however, because the lower daily tonnage base at each would increase unit costs.

CONSTRUCTION AND DEMOLITION SOLID WASTES are considered in this Report in two fractions. One fraction is, typically, from residential and small commercial building demolition and repair. Solid wastes associated with these activities are normally bulky and hauled in smaller quantities. These are considered part of residential and commercial wastes acceptable at a sanitary landfill.

The larger fraction of demolition and construction wastes results from major construction projects. Loads of earth, brick, broken concrete, and broken asphalt are normally not waste but can be salvaged for beneficial use as solid fill on low lots. Large pieces of concrete, pipes, and timbers must be broken or cut to convenient size for equipment to place in a fill. These operations are accomplished more efficiently by the contractors than by landfill operators. This plan for disposal of solid wastes does not include provision for solid fill from major demolition or construction projects.

Municipalities may benefit from designating certain sites for spoil areas when fill is needed, but that procedure is not considered a part of the solid wastes disposal plan. It is a special, limited, salvage operation.

TRAFFIC AND RECREATIONAL SOLID WASTES include street sweepings; wastes from litter cans; wastes from parks, picnic areas, public buildings, etc. These wastes accumulate on all streets and at parks, ball fields, stadiums, etc. Traffic and recreational solid wastes are included in the disposal plan. Abandoned car bodies are expected to be salvaged by private enterprise and are not included here for disposal.

AGRICULTURAL SOLID WASTES are expected to be disposed on site with few exceptions. Provisions for some agricultural solid wastes occurring close to urban areas are to be included in the disposal plan. Private haul to the disposal site is expected, and no provision is made for public haul.

PROJECTED AMOUNTS OF SOLID WASTES

A tabulation on Page S 4-63 lists rates at which solid wastes were disposed from communities in Maricopa County and projected rates. On Page S 4-56 kinds of solid wastes are related as percentages of total solid wastes. Tucson, Phoenix, and Los Angeles recorded 5.1 to 5.2 pounds per capita per day of "residential" plus "commercial" solid wastes. Or, under the classification given above, all wastes except agricultural and heavy construction and demolition wastes are included at 5.1 pounds per capita per day. These are the kinds of wastes for which this program of haul and disposal is made.

On Page S 4-63 projected rates have been raised above existing rates simply to be conservative and make some allowance for an upward trend if it does occur. Commercial and industrial solid wastes rates are included in those projections in the relationship to population which was found to be true of Phoenix and Los Angeles.

Population projections are included in Section 3 of this Report. In Table CP-T1 (Page S 6-9), Projected Solid Wastes Production, estimated rates of production and estimated populations are factors on which corresponding estimated daily tonnages are based. Phoenix population projections have been subdivided into nominal quarters to correspond to planned collection areas. Boundaries of those quarters are as follows:

NW 1/4	Indian School Road and 7th Avenue
NE 1/4	Camelback Road and 7th Avenue
SE 1/4	Camelback Road and 7th Street
SW 1/4	Indian School Road and 7th Street

Table CP-T1

PROJECTED SOLID WASTES PRODUCTION

(Not Including
Construction and Demolition Wastes)

		1970-1980		1980-1990		1990-2000	
Place	Solid Wastes Rate Lbs/Cap per Day	Avg Population Thousands	Solid Wastes Tons per Day	Avg Population Thousands	Solid Wastes Tons per Day	Avg Population Thousands	Solid Wastes Tons per Day
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Phoenix	5. 5	835	2, 300	1, 197	3, 290	1, 547	4, 255
NE 1/4	5. 5	148	407	237	653	324	891
NW 1/4	5. 5	190	523	260	715	329	905
SE 1/4	5. 5	232	638	299	822	364	1, 001
SW 1/4	5. 5	265	732	400	1, 100	530	1, 458
N 1/2	5. 5	338	930	498	1, 370	653	1, 796
S 1/2	5. 5	497	1, 367	699	1, 922	894	2, 459
E 1/2	5. 5	380	1, 045	537	1, 475	688	1, 892
W 1/2	5. 5	455	1, 252	660	1, 815	859	2, 362
Avondale	4. 5	9	20	11	25	14	32
Buckeye	4. 5	4	9	5	10	6	14
Cave Creek	4. 5	3	7	4	9	5	10
Chandler	4. 5	20	45	27	61	35	79
El Mirage	4. 5	5	10	6	14	7	16
Gila Bend	4. 5	3	7	4	9	5	10
Gilbert	4. 5	3	7	4	9	5	10
Glendale	4. 5	63	141	100	225	140	315
Goodyear	4. 5	3	7	4	9	5	10
Litchfield Park	4. 5	21	46	44	98	68	153
Mesa	4. 5	88	199	124	280	171	385
Paradise Valley	4. 5	7	16	9	20	13	28
Peoria	4. 5	7	16	10	23	13	29
Scottsdale	4. 5	90	203	133	299	178	401
Surprise	4. 5	4	9	5	11	7	16
Tempe	4. 5	80	180	113	254	155	349
Tolleson	4. 5	8	18	11	25	14	32
Wickenburg	4. 5	3	7	3	7	3	7
Sun City	2. 5	24	29	38	47	48	59
Youngtown	2. 5	3	3	4	4	4	5

Estimated population centroids are indicated on Plate CP-P1 (Page S 6-30) for each community and four Phoenix collection areas. Estimated average daily tonnage production at each centroid is indicated for the decade 1970 to 1980. These production rates include all solid wastes produced except construction, demolition, and agricultural solid wastes.

ALTERNATE DISPOSAL METHODS

DISPOSAL ON LAND: Open dumps, burning dumps, landfills, and sanitary landfills could be developed to receive every kind of solid wastes in the County. Of these four methods only sanitary landfills are sanitary. Dumps and landfills fail to control fires, flies, windblown trash, mechanical hazards, scavengers, appearances, and odors. Open burning violates County Health Department regulations.

Sanitary landfills can meet all the requirements of the total disposal problem. Economics of sanitary landfill operations in the County are discussed later in this section, and it is demonstrated to be the least expensive adequate disposal method known for Maricopa County.

Residue from incinerators must be disposed on land. Residue from salvage operations, including composting, must be disposed on land.

DISPOSAL IN AIR: Incineration of solid wastes changes the state of combustible components from solid to gas and discharges the gases, with fly ash and moisture, into the air. Ashes remaining for disposal on land are a small fraction of the original volume.

The primary purpose of incineration is to reduce the volume of solid wastes. Weight reduction is achieved about equal to the weight of gases discharged. Volume reduction would appear to decrease sanitary landfill costs, but costs of incineration must be considered. Haul costs would be lower where the incinerator is located substantially nearer a collection centroid than the landfill is.

A consideration for application of incineration under the most favorable conditions for incineration provides a test for possible use in the County.

Most favorable conditions for application of the incineration method include the following:

1. Large, uniform, daily tonnage of combustible wastes concentrated about a centroid which is remote from an alternate sanitary landfill site and close to an incinerator plant site. These conditions would provide an opportunity to save on haul costs while operating near design capacity.

2. In lieu of standby incineration capacity a sanitary landfill is within reasonable haul distance on an emergency basis for as much as a two-week period. These conditions would provide an opportunity to save on first costs.

3. Relatively uniform quality of solid wastes for incinerator feed and a relatively steady thermal, volume, and weight input while operating near design capacity. These conditions would provide an opportunity to minimize maintenance and operation costs.

4. No conditions are foreseen which indicate that salvage of waste heat per se should be considered.

In Section 2 first cost plus operating cost of incineration was estimated to be $4.20 per ton at 500 tons per day and $4.01 per ton at 1,000 tons per day. The difference, $0.19 per ton, is equivalent to 4.5 percent of $4.20. Haul cost in packer trucks on arterial streets in Phoenix is $0.12 per ton-mile.

A collection area, from which 500 tons per day would be assured and would provide a minimum haul distance, is bounded by Indian School Road, 32nd Street, Southern Avenue, and 35th Avenue. The collection centroid would be at about Van Buren Street and 7th Avenue. The mean haul distance would be 2 miles. The maximum haul distance would be 8 miles. The weighted average haul distance would be 3.6 miles.

A 1,000-ton per day incinerator would increase the economic haul distance less than one mile thereby enlarging the collection area a corresponding amount.

Enlarging the 500-ton per day collection area by adding a peripheral strip one mile in width would not ensure 1,000 tons per day of wastes. Therefore the computation is made for a 500-ton per day incinerator. The comparative tabulation below is based upon operating at full capacity for 6 days per week, except for 14 days downtime per year. During downtime 500 tons per day would go to sanitary landfill, and the cost for standby equipment at the landfill is charged to incineration.

The Phoenix site was selected as the site in Maricopa County most favorable for incineration.

ESTIMATED COST OF HAUL AND INCINERATION

500-TON INCINERATOR OPERATING AT DESIGN CAPACITY

HAUL COST

	Daily Haul			Unit Cost	Daily Haul Cost	Unit Cost	Cumulative Unit Cost
Vehicle	Tons	Mi.	Ton-Mi.	$	$	$/Ton	$/Ton
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
3-Man packer trucks	335	3.6	1,200	0.24	288	0.86	
3-Man open trucks	165	3.6	600	0.52	312	1.89	
Total	500	3.6	1,800		600		
Weighted avg.	500			0.33		1.20	1.20

INCINERATION COST

Incineration first cost plus operating cost (includes land)		4.20	5.40
Minimum maintenance cost		0.10	5.50
Plant waste disposal cost (estimate 15% waste)			
	$/Ton		
Haul: 1 ton x .15x 51 miles x $0.10/mile	0.76		
Landfill disposal: 1 ton x .15x $1.65 per ton	0.25		
Total plant waste disposal cost		1.01	6.51
Equipment			
2 track dozers, depreciated cost: 2 @ $20,000 $40,000 ÷ (7,000 tons per year x 15 years)		0.38	6.89
Total haul and incineration unit cost per ton			$6.89

For comparison of sanitary landfill costs for the same 500 tons per day from the same area, the landfill site is assumed to be near 27th Avenue and 9 miles north of Bell Road, 3 miles outside the Metropolitan

Study Area. Haul distances would be 2.5 miles off the freeway and 22 miles on Black Canyon Freeway.

The tabulation below illustrates the estimated unit costs, in dollars per ton, of haul and disposal by sanitary landfill:

COST OF HAUL AND SANITARY LANDFILL

HAUL COST

Vehicle (1)	Wt Tons (2)	Dist Miles (3)	Unit Ton-Mi (4)	Unit Cost $ (5)	Cost $ (6)	Subtotals $ (7)	Subtotals % (8)
Off Freeway							
3-Man packer trucks	0.67	2.5	1.67	0.24	0.40		
1-Man open trucks	0.33	2.5	0.83	0.24	0.20	0.60	12
On Freeway							
3-Man packer trucks	0.67	22.0	14.7	0.14	2.06		
1-Man open trucks	0.33	22.0	7.3	0.12	0.88	2.94	57

SANITARY LANDFILL COST

	$	%
Disposal cost (Phoenix 1967, includes land)	1.65	31
Total unit cost for haul and disposal, per ton	$5.19	100

Estimated cost of haul and disposal by incineration, $6.89 per ton, exceeds that by sanitary landfill, $5.19 per ton, by $1.70 per ton. At 500 tons per day and $1.70 per ton, the annual saving by sanitary landfill would be $266,050. In this case a selected set of conditions favoring incineration was used as a basis for cost estimating. Adverse landfill conditions were assumed for comparison. At best, municipal incineration promises an annual loss as compared to municipal sanitary landfill.

Using existing sanitary landfill sites along the Salt River, the centroid to site distance (for the same 500 tons per day in the example above) would be 2.5 miles. Weighted average haul cost would be about $1.30 per ton. Sanitary landfill now costs $1.65 per ton. Haul and disposal by sanitary landfill would cost $2.95.

Haul and incineration cost	$ 6.89	per ton
Haul and sanitary landfill cost	2.95	per ton
Saving by sanitary landfill	$ 3.94	per ton
	x 500	tons per day
Saving by sanitary landfill	$ 1,970.00	per day
	x 313	annual working days
Saving by sanitary landfill	$616,610.00	per year

At 500 tons per day and 7,000 tons per gross acre in sanitary landfill, 660 acres would be required for disposal by the year 2000. Coupled with proposed Salt River channel improvements this acreage is not impractical.

When nearby sites for sanitary landfill disposal are no longer available (and land cost is not a dominant factor), haul cost will determine the feasibility of incineration. The haul distance break-even point is equivalent to $5.24 per ton divided by $0.14 per ton-mile, or 37 miles one way.

But by building a transfer station in lieu of the incinerator, a longer distance is feasible to a sanitary landfill. Estimated cost of transfer is $1.00 per ton (Orange County, $0.64 to $0.90). Haul by special long-haul truck and trailer equipment is estimated to cost $0.03 per ton-mile by freeway (Orange County, 1965, $0.016 per ton-mile).

Saving by sanitary landfill	$5.24 per ton
Less cost of transfer	1.00
Available for additional haul	$4.24 per ton

$4.24 ÷ $0.03 per ton-mile = 140 miles round trip
Break-even haul distance = 70 miles one way

Incineration may prove feasible, without improved technology, when landfill sites within 70 miles have been used.

SPECIAL WASTES AT SANITARY LANDFILLS

Kinds of special wastes are indicated in Table I-T3 (Page S 1-15). In addition to those which are special because of composition there are those which are special because of size, shape, and weight.

DEAD ANIMALS create two basic problems:

1. Bodies of pets and livestock must be picked up promptly when reported.

Special sanitation crews will continue to be required to do part of this work. Disposal of livestock bodies will usually be accomplished by rendering. Disposal at landfills, by burial, will be more efficient where excess haul to rendering would be involved.

Disposal of pet bodies by either burial or cremation is acceptable to the public. In 1967 about 140 dogs and 400 cats were cremated or buried in one day by the Maricopa County Veterinary Center and the two Humane Societies in the Metropolitan Study Area.

2. Individual cremation or burial is impractical for that many.

To own and operate a modern, large crematory destructor rated at 2,400 pounds per day would cost about $0.05 per pound of wastes destroyed. Three units at three sites would cost about $110,000 per year, owning and operating cost, to cremate 7,000 pounds daily of animal bodies and the accompanying pen litter. Buried in landfill at $2.00 per ton, 7,000 pounds daily would cost about $2,200 per year. Cremation is a sanitary method of disposal for animal bodies but costs about fifty times as much as disposal cost by sanitary landfill.

PATHOLOGICAL WASTES from hospitals, clinics, and similar institutions are frequently contaminated and dangerous to human health. They should continue to be destroyed by high temperature incineration on site where professional supervisors are responsible for control methods.

SEWAGE RESIDUE pumped from cesspools amounted to about 70 tons, or about 15,000 gallons, per average day at two Phoenix landfills in 1966.

Pumpage from cesspools is one waste that should be minimized. A record should be kept of the source of each load and this record reported to the Maricopa County Health Department. Where an active cesspool is located on property serviced by an existing sewer line, the owner should be required to connect to the sewer line. This procedure would to some extent reduce the amount of cesspool waste received at the landfills.

Anaerobic digestion of sewage residue within a sanitary landfill is not objectionable. Ponding septic sewage on top of a sanitary landfill causes three principal problems:

1. Odors and insects must be controlled by expensive chemical sprays.
2. Ponds must be isolated from ready access by the general public for health reasons and appearances.
3. Pond areas interfere with progress toward completion of the site plan.

A minimum pond area would minimize these three problems. Injection of slurries by pumping from a receiving tank into a sanitary landfill would prevent pond surface exposure. Drainage from a trench into a sanitary landfill would provide minimum pond surface exposure. Shallow drill holes from the trench bottom into the sanitary landfill would provide more rapid drainage than a dirt bottom of a pond. Drill holes would provide minimum solid waste exposure but would be expected to vent gases until backfilled.

ABANDONED VEHICLES present a legal problem in determining that they are, in fact, abandoned. Auto and truck bodies are expected to be salvaged in Maricopa County for the foreseeable future. Wastes remaining after salvage should be buried in sanitary landfills.

CHEMICAL WASTES result from industrial and agricultural processes and should be neutralized prior to arrival at a sanitary landfill. Personnel at sanitary landfills are not expected to be chemists and should not be subjected to unnecessary hazards.

RADIOACTIVE WASTES AND EXPLOSIVES should be disposed of by specially trained men and not by sanitary landfill personnel.

LARGE LOGS AND STUMPS should not be refused at all sanitary landfills. It is reasonable to expect additional truck haul distance beyond the nearest disposal site, but if no site is provided, promiscuous dumping will result. A large chain saw should be provided at each site designated to receive oversize logs and stumps. A special fee can be charged for the cost of cutting oversize items into pieces that can be placed by disposal equipment.

IN GENERAL, provision should be made for disposal of unusual and awkward items to prevent promiscuous dumping. Longer haul can be tolerated where special equipment and training can be provided at only one site in the Metropolitan Study Area.

Certain specialized wastes can better be disposed at special sites, and certain specialized wastes require special equipment for haul and disposal. It is expected that these matters will be considered in a subsequent phase of this study.

1970-1980 SOLID WASTES DISPOSAL PROGRAM

GENERAL: Disposal by sanitary landfill is the basis of the 1970-1980 program. Basic considerations in formulating the program are locations of potential landfill sites, locations and amounts of solid wastes, and efficient applications of haul and disposal fundamentals.

LOCATION OF POTENTIAL LANDFILL SITES: Rough, unimproved terrain located nearest to population centroids is, commonly, adjacent to rivers passing through the Metropolitan Study Area. Soil to depth of stream bed elevation at these sites is, commonly, silt, sand, and gravel. Groundwater level is, commonly, more than 50 feet below stream bed. Stream beds are normally dry, with turbulent, eroding flow following short, intense, infrequent rainstorms.

More specific locations of good potential are inactive borrow pits.

Locations of borrow pits are tabulated below from records of the Maricopa County Highway Department:

Township	Range	Section	Pit No.	Ownership or Control
Southwest				
1S	2W	5	65	USBLM
		8	64	USBLM
		8	84	USBLM
		9	83	USBLM
		16	78	Coy and Jones
		21	82	USBLM
		21	77	Coy and Jones
1S	3W	13	136	Swain
		18		
Northwest				
1N	1W	2	42	Brewster
		11		
		11	41	Skelly
		14	104	Vermeersch

Township	Range	Section	Pit No.	Ownership or Control
Northwest, continued				
		22	90	Vermeersch
		22	97	Vermeersch
		23	89	Vermeersch
		23	91	Linville
1N	2W	17	43	Belluzzi
1N	3W	5	74	USBLM
		5		USBLM
		8	73	USBLM
2N	1W	12	47	Goodyear Farms
		12		
		18	62	Mullins
2N	2W	8	66	MCMWCD #1
		12	48	Rogers
2N	3W	34		
		35		
3N	1W	1	172A	Maricopa County
		1	159	USBLM
		25	49	Fisher
		25		
3N	2W	26	51	MCMWCD #1
		26	52	Anderson
		26	61	MCMWCD #1
4N	1W	25		
		27	47	Anderson
Southeast				
1S	3E	9		Jordan
1S	4E	5	53	Gold
		6		
1S	5E	3	87	Macco Corp.
1S	7E	17	54	Walker
2S	4E	9	56	Roosevelt Water Cons. Dist.
2S	5E	27	27	Spreckels Sugar
2S	7E	25	57	Schnepe
Northeast				
1N	1E	32		
1N	2E	22	4	Fisher

Township	Range	Section	Pit No.	Ownership or Control
Northeast, continued				
1N	2E	29	45	US Bureau of Rec.
		29	158	US Bureau of Rec.
1N	3E	19	20	Fisher
		21		
		23	94	Moore
1N	4E	13	17	Jacobs
		13	18	Whiting
		14	16	US Bureau of Rec.
		18	11	US Bureau of Rec.
1N	5E	19	123	Gillarde
1N	7E	18	100	Anderson
		32	96	State Land
2N	1E	5		
2N	3E	13		
2N	6E	13	141	US Bureau of Rec.
		13	140	US Bureau of Rec.
		14	140	US Bureau of Rec.
		29		
3N	1E	19	101	Youngtown Land & Development Co.
		30	95	Noore
3N	2E	12	25	Mitchell
		12	25	
		12	26	Lynden
		13	28	Cove Ranch
		16	28	State of Arizona
		20	31	Benvenuti
3N	3E	6		
		6	30	Ledbetter
		16		
3N	5E	22	108	Hirsh
4N	1E	2		
		11	110	Lyle Patrick
		23		
		36		
4N	2E	2		
		11	137	State
		28	37	Medigovich
		31	36	Robinson & Accola

Township	Range	Section	Pit No.	Ownership or Control
Northeast, continued				
4N	3E	3	48	State
		21		
		32	38	Phythian
4N	4E	22		
		34		

Some borrow pits have been developed because sand, gravel, or clay was exposed at the surface. Other borrow pits were located by subsurface investigation near proposed highway construction. An existing borrow pit with easy and short access to a major highway or freeway may be a better site than one closer to the population centroid. Unit haul cost, in dollars per ton-mile, is less expensive on higher speed roadways.

Areas are indicated as possible future sanitary landfill sites as results of preliminary studies by municipalities and include the following:

Phoenix owns these potential sites

1. West of 91st Avenue Sewage Treatment Plant
2. 67th Avenue on north bank of Salt River
3. 3rd Street and Beardsley Road

Sites under study by Phoenix include the following

Collection Area	Area in Acres	Number of Parcels	Estimated Requirements 1970-1980 Acres
N 1/2	884	5	480
SE 1/4	380	7	330
SW 1/4	1,871	11	380
Totals	3,135	23	1,190

Mesa has studied three major potential sites along the Salt River, one near Country Club Drive, one east of Bee Line Highway, and an extensive area near their sewage treatment plant.

Mesa and Scottsdale are considering continued use of the tri-community landfill along the Salt River on the Salt River Indian Reservation. Tempe is considering joining the tri-community program.

Glendale is studying seven sites which total 757 acres of land suitable for landfill. The Glendale area program is estimated to require 150 acres in the 1970-1980 decade.

Specific site plans are beyond the scope of this Report, but those factors mentioned below should be considered in specific planning.

Each potential landfill site must be evaluated in relation to its present use, future use, capacity, distance from population centroid, topography, and existing or proposed highways or freeways.

As a new gravel pit a site is not suitable for landfill; depleted of gravel, the site topography may be near optimum. A site to be developed as an open space park in eight years may require immediate development as a sanitary landfill in the first phase of developing the park. Capacity of a site may be limited, physically or in time, by a succeeding phase of site development.

LOCATIONS AND AMOUNTS OF SOLID WASTES: For the purposes of this Report land requirements for sanitary landfill sites are estimated by decades. Some typical site capacities were estimated as a basis for determining approximate land area requirements.

Site capacity estimates are summarized as follows:

Description of Site	Gross Area	Site Capacity Tons	Site Capacity Tons/Acre
Tract cut by dry wash	40	267,000	6,700
Tract cut by dry wash	160	2,984,000	18,600
Tract near Salt River			
Before flood control structures	160	806,000	5,000
After flood control structures	160	1,400,000	8,700

Subsequent estimates are based on a capacity of 7,000 tons per acre.

Table CP-T2 (Page S 6-26) lists estimated land areas required by major solid wastes producers in the decade 1970-1980. Table CP-T3 (Page S 6-27) lists regional land area requirements where the entire County population contributes to the loading. Plate CP-P3 (Page S 6-36) indicates centroids and daily tonnage forecasts.

EFFICIENT APPLICATION OF HAUL AND DISPOSAL FUNDAMENTALS: Regional interests are best served by improved collection and disposal of solid wastes from each production source. Disposal costs per ton decrease as the tonnage increases. Tonnage at a disposal site may be increased by improving collection practices and by combining wastes from more sources. Increasing tonnage by increasing collection effort does not lower overall costs but is desirable for good appearances sake. With few special exceptions combining wastes otherwise disposed at separate sites does reduce unit disposal costs. However, separate sites may minimize haul costs.

The purposes of regional solid wastes disposal programs are to minimize total costs and provide service to areas not otherwise serviceable.

Table CP-T2

PROJECTED DISPOSAL AREA REQUIREMENTS

Sanitary Landfill at 7,000 Tons per Acre

1970 - 1980

Place	Production Rate 1,000 Tons per Year	Disposal Area Requirements	
		Acres per Year	Acres per 10 Years
(1)	(2)	(3)	(4)
Phoenix	843	119	1,190
SE 1/4	233	33	330
NE 1/4	150	21	210
NW 1/4	190	27	270
SW 1/4	270	38	380
Gilbert	3	0.4	4
Chandler	16	2.3	23
Tempe	66	9.4	94
Mesa	72	10.2	102
Scottsdale	74	10.5	105
Paradise Valley	6	0.9	9
Cave Creek	3	0.4	4
Glendale	52	7.4	74
Peoria	6	0.9	9
Sun City	11	1.6	16
Youngtown	1	0.1	1
El Mirage	4	0.6	6
Surprise	3	0.4	4
Wickenburg	3	0.4	4
Tolleson	7	1.0	10
Avondale	7	1.0	10
Goodyear	3	0.4	4
Litchfield Park	17	2.4	24
Buckeye	3	0.4	4
Gila Bend	3	0.4	4
Total			1,711

Table CP-T3

SUMMARY OF LAND AREA REQUIREMENTS FOR SANITARY LANDFILL, 1970-2000

(Includes Dispersed Population Area Requirement)

	Decades			Total	
	1970-1980	1980-1990	1990-2000	1970-2000	
Regions	Acres	Acres	Acres	Acres	Sq Miles
(1)	(2)	(3)	(4)	(5)	(6)
Central Region					
Phoenix	1,190	1,710	2,200	5,100	
County	43	51	61	155	
Subtotal	1,233	1,761	2,261	5,255	8.22
Southwest Region					
Gila Bend	4	4	6	14	
Buckeye	4	6	7	17	
County	6	8	9	23	
Subtotal	14	18	22	54	0.08
West Central Region					
Tolleson	10	13	16	39	
Avondale	10	13	16	39	
Goodyear	4	4	6	14	
Litchfield Park	24	51	80	155	
County	32	39	46	117	
Subtotal	80	120	164	364	0.57
Northwest Region					
Glendale	74	117	166	357	
Peoria	9	11	16	36	
Sun City	16	24	31	71	
Youngtown	1	3	3	7	
El Mirage	6	7	9	22	
Surprise	4	6	9	19	
County	32	39	46	117	
Subtotal	142	207	280	629	0.98
Northeast Region					
Mesa	102	141	196	439	
Scottsdale	105	151	206	462	
Paradise Valley	9	10	16	35	
Cave Creek	4	4	6	14	
County	54	65	76	195	
Subtotal	274	371	500	1,145	1.79
Southeast Region					
Tempe	94	129	185	408	
Chandler	23	31	40	94	
Gilbert	4	4	6	14	
County	43	51	61	155	
Subtotal	164	215	292	671	1.05
Wickenburg Region					
Wickenburg	4	4	4	12	
County	4	5	6	15	
Subtotal	8	9	10	27	0.04
County Total	1,915	2,701	3,529	8,145	12.73

EVALUATION OF REGIONAL SANITARY LANDFILLS

A purpose of this study was to make an estimate of costs as a basis for determining feasibility of regional sanitary landfills in the County. Communities and the County are the entities to be responsible for haul and disposal. Costs of cooperative efforts were compared to costs of individual efforts.

The schedule includes costs for disposal of estimated wastes from populations projected within the County in the next decade, 1970 to 1980. Collection costs were not considered. Where haul cost for an isolated, small community was considered prohibitive for that community, haul cost was debited to the County on the theory that benefits were more than community wide.

Unit prices of 1967 were used throughout because haul and disposal costs were, in both cases, largely for labor, equipment, and fuel. Therefore comparisons, by difference, were valid when based on 1967 unit prices.

Estimated unit costs for haul were based upon reported actual costs. Reported actual costs included the following:

Reference		Conditions	Cost $/ Ton-Mile
Phoenix	1965	Arterial streets, 3-man packer	0.12
Riverside	1965	City streets, 2-man packer	0.114
Orange Co.	1965	City streets, 2-man packer	0.114
Phoenix	1965	Freeway, 3-man packer	0.07
Riverside	1965	Freeway, 1-man tandem trailer	0.029
Orange Co.	1965	Freeway, 1-man tandem trailer	0.016

Estimated unit costs were based on 2-man packer truck operation on arterial streets, county roads, state highways, and freeways. A 1965 cost of $0.114 per ton-mile was estimated to be $0.12 per ton-mile in 1967. Average city street travel was estimated to be at 22 miles per hour. Average county road travel was estimated to be at 33 miles per hour. County road haul cost was estimated to be $0.08 per ton-mile by inverse proportion to average haul speed. Average highway and freeway travel was estimated to be at 53 miles per hour. Highway and freeway haul cost was estimated to be $0.05 per ton-mile.

Estimated unit costs for disposal by sanitary landfill were based upon equipment and labor costs for small and larger operations and, for larger operations, upon actual costs reported by communities.

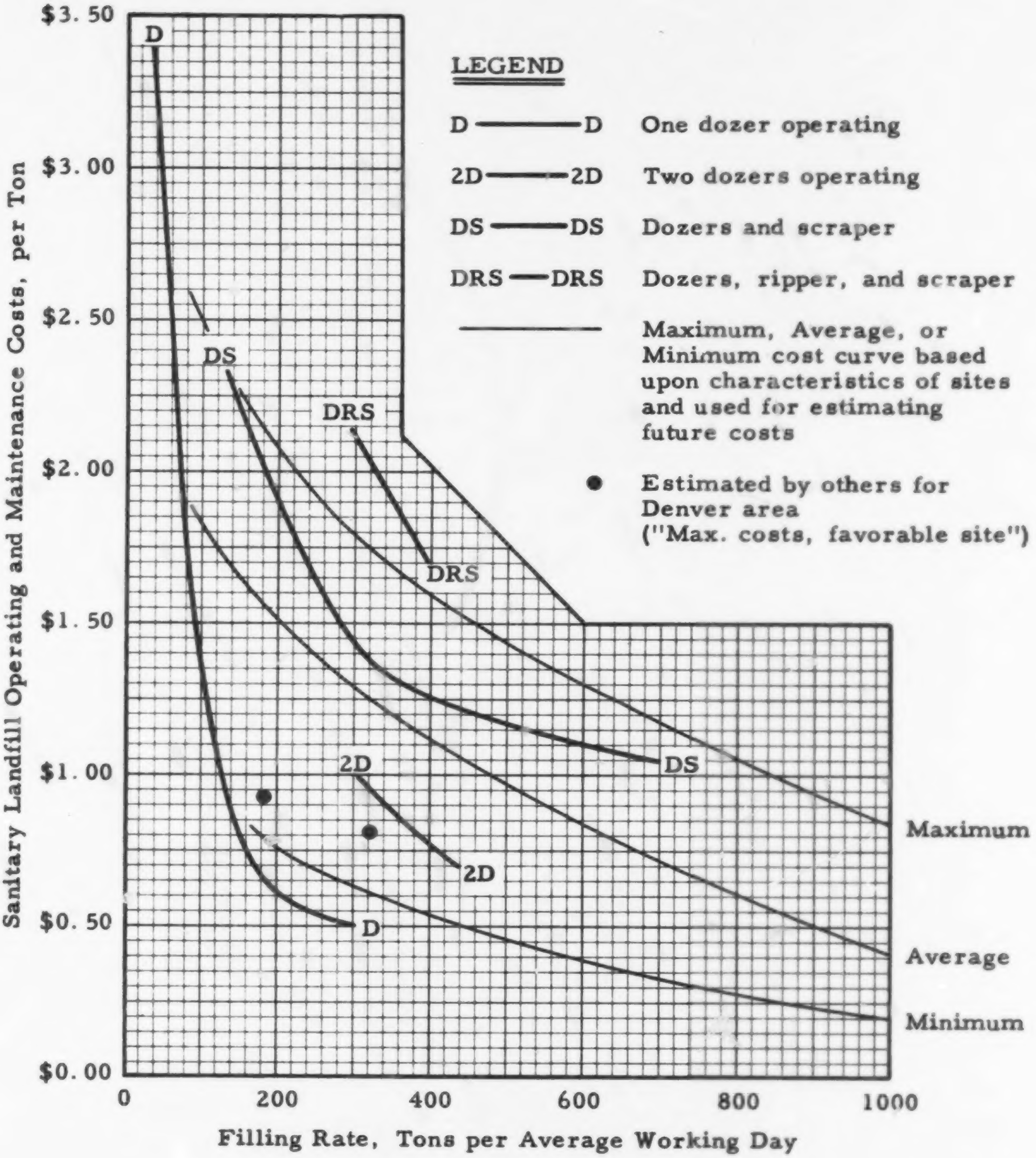
BASED ON TRENCH OPERATION BY ONE MACHINE

(Fixed Owning and Operating Cost: $400 per Week)

Tons per Day	Tons/Week (6 Days)	Tons/Year (312 Days)	$ per Ton
4	24	1,250	16.70
6	36	1,880	11.10
8	48	2,500	8.30
10	60	3,130	6.70
12	72	3,750	5.60
14	84	4,380	4.80
16	96	5,000	4.20
18	108	5,630	3.70
20	120	6,250	3.30

Site characteristics pose some problems. Special equipment would be needed to solve these problems.

Plate CP-P1



ESTIMATED SANITARY LANDFILL

OPERATION AND MAINTENANCE COSTS

(Based upon Equipment Owning & Operating Costs)

Site Characteristics	Special Problems	Basic Equipment
1. Cover Material		
Loose soil, short haul	None	Track dozer
Loose soil, long haul	Long haul	Dozer-scraper
Hard soil, short haul	Hard soil	Dozer-ripper
Hard soil, long haul	Soil and haul	Dozer-ripper-scraper
2. Excavation		
Pit, minimum	None	Track dozer
Wash, average	Excess volume	Dozer-scraper
Flat, maximum	Maximum volume	Dozer and scraper or dozer and dragline

Combined problems related to excavation and cover material may range from all minimum in the most favorable location to all maximum in the least favorable.

On Plate CP-P1 estimated unit operating and maintenance costs indicate effects of selecting equipment as required by site characteristics and filling rates. Line D-D is a composite cost curve for one dozer (five different sizes) with capacity to meet the filling rate working alone in a favorable site. Line 2D-2D indicates the effect of duplicating a large dozer at 300 tons per day, initially doubling the unit cost then tending toward more efficiency as the filling rate increases.

Line DS-DS indicates the effect of long haul for cover material where a second dozer and a scraper are needed. Line DRS-DRS indicates the additional cost of equipment time where hard soil requires ripping and loading is more difficult.

Maximum, minimum, and average cost curves used in subsequent estimating are superimposed upon this graph for comparison.

On Plate CP-P2 (Page S 6-33) those estimating cost curves are superimposed upon a graph which indicates recorded sanitary landfill costs.

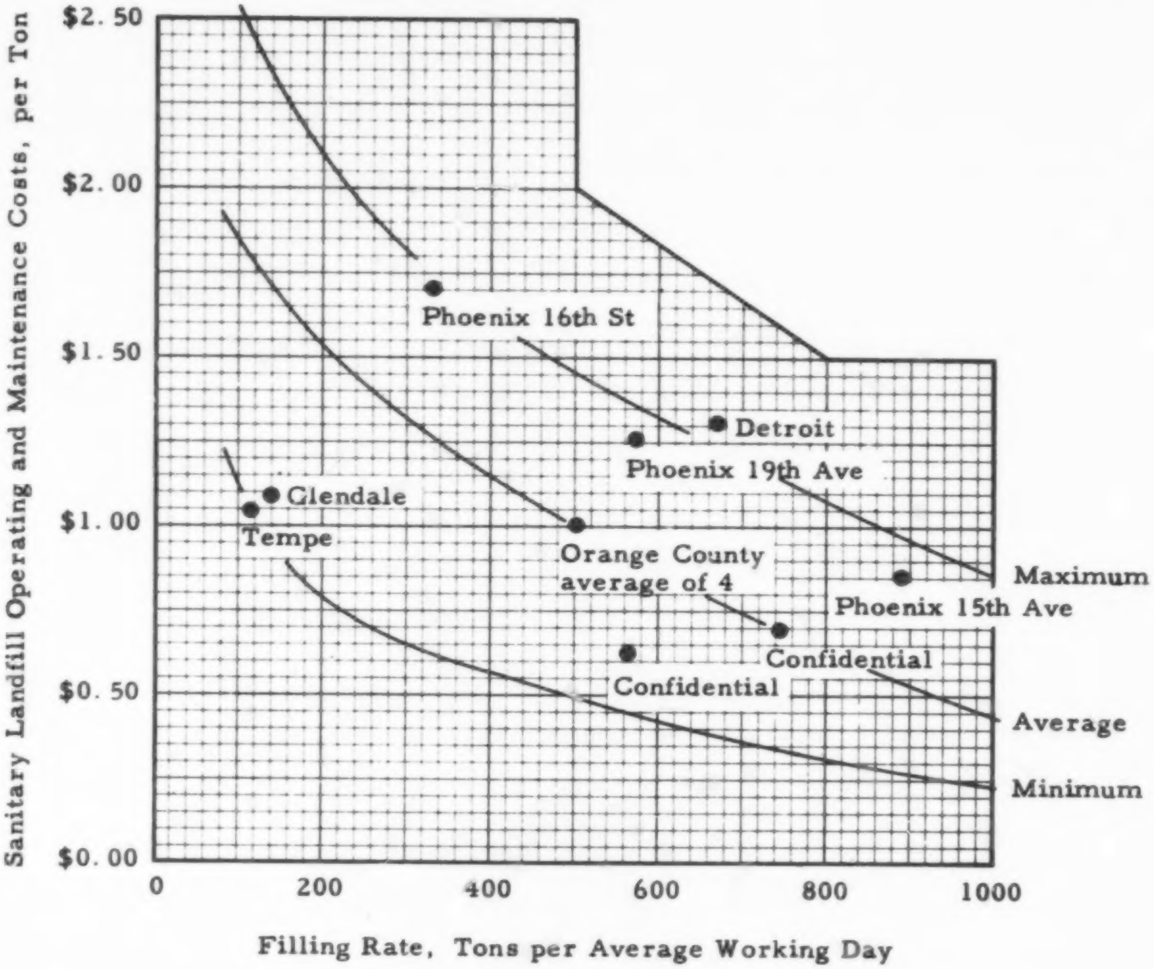
Tempe and Glendale sites are favorable sites and their costs are the two lowest reported. Orange County, California costs are reported as a total at four sites with a total tonnage rate of 2,200 per working day. Two cost records designated "confidential" come from sites with minimum excavation but unfavorable haul for earth cover. The Detroit site characteristics are unfavorable. Phoenix sites are not favorable. The 16th Street site requires expensive excavation and earth cover haul. The 19th Avenue site requires excessive excavation in firm soil. The 15th Avenue site requires about average excavation and average haul. In reviewing these cost records it is important to add that compactive effort records or density records do not exist, except for the special test made at the 16th Street site in Phoenix in 1967. Cost of various amounts of compaction effort are included in these recorded costs but cannot be evaluated.

Land cost for sanitary landfill was estimated on the basis of a ratio: 7,000 tons placed per gross acre. Thus, for example, at $3,000 per acre the land cost rate would be $0.43 per ton. Alternate land lease rates should be compared to land ownership rates on the same units, dollars per net ton of waste. Effective lease rates can be insignificant, as in Glendale, where land use by Glendale is equated to land

Plate CP-P2

LEGEND

- ● Reported filling rate and cost.
- ——Maximum, Average, or Minimum cost curve based upon characteristics of sites and used for estimating future costs.



RECORDED SANITARY LANDFILL

OPERATION AND MAINTENANCE COSTS

improvement favoring the owner. Credit may be taken for improvement of city-owned land, as in Tempe and the city-owned park site at 19th Avenue in Phoenix.

In subsequent cost comparisons land cost of $0.50 per ton has been used to make the total costs reflect a probable ability to acquire a site considered. This is equivalent to a purchase price of $3,500 per gross acre. Costs are not included for a revolving fund.

On Plate CP-P3 (Page S 6-36) 1970-1980 waste centroids are indicated for each community. Individual tonnage rates are indicated for that decade. In Table CP-T3 (Page S 6-27) regional areas, for combined disposal programs, are listed by their directions from the center of the metropolitan area. For example: Gila Bend, Buckeye, and the Hassayampa Valley are "Southwest." Alternate combinations of communities are listed in Table CP-T4 (Page S 6-35) and relative cost benefits are indicated. Alternate disposal sites are included for comparison of probable cost differentials.

SOUTHWEST REGION: Gila Bend, Buckeye, and the County (Hassayampa Valley) would each benefit from a program including a sanitary landfill between Buckeye and Gila Bend. Regional savings, $34,000 annually, is the cost difference between three individual operations at $69,600 and a regional operation at $35,600. (Table CP-T4, Page S 6-35)

An apparent saving in annual disposal costs, $39,400 ($62,400 minus $23,000), is reduced by an increase in annual haul cost $5,400 ($12,600 minus $7,200). But individual operations are estimated to cost about two times as much as regional operation in the southwest region.

Table CP-T4

COMPARISON OF ESTIMATED OPERATING COSTS FOR THREE REGIONAL SANITARY LANDFILLS AND INDIVIDUAL COMMUNITY SANITARY LANDFILLS

DECADE: 1970-1980

COMMUNITY		REGIONAL OPERATION									INDIVIDUAL OPERATION								
	Solid Wastes		Haul Costs		Disposal Costs		Haul & Disp. Costs		Payment			Haul Costs		Disposal Costs		Haul & Disp. Costs		Payment	
	Tons/Yr	Haul Dist. Miles	Unit $/Ton	Annual $	Unit $/Ton	Annual $	Unit $/Ton	Annual $	Unit $/Ton	Annual $	Haul Dist. Miles	Unit $/Ton	Annual $	Unit $/Ton	Annual $	Unit $/Ton	Annual $	Unit $/Ton	Annual $
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Southwest																			
Gila Bend	2,482	62	3.10	7,700	3.10	7,700	6.20	15,400	3.10	7,700	6	0.96	2,400	8.38	20,800	9.34	23,200	9.34	23,200
Buckeye	3,285	20	1.00	3,300	3.10	10,200	4.10	13,500	3.10	10,200	8	0.96	3,200	6.33	20,800	7.29	24,000	7.29	24,000
County	1,643	20	1.00	1,600	3.10	5,100	4.10	6,700	-	17,700	20	1.00	1,600	12.65	20,800	13.65	22,400	13.65	22,400
Total	7,410		1.70*	12,600	3.10*	23,000	4.80*	35,600	4.80*	35,600		0.97*	7,200	8.42*	62,400	9.39*	69,600	9.39*	69,600
West Central																			
Goodyear	2,482	18	1.44	3,600	2.20	5,500	3.64	9,100	2.20	5,500	8	0.96	2,400	8.38	20,800	9.34	23,200	9.34	23,200
Avondale	7,410	16	1.28	9,500	2.20	16,300	3.48	25,800	2.20	16,300	8	0.96	7,100	2.80	20,800	3.76	27,900	3.76	27,900
Litchfield Park	17,264	26	2.08	35,900	2.20	38,000	4.28	73,900	2.20	38,000	8	0.96	16,600	2.50	43,200	3.46	59,800	3.46	59,800
Tolleson	6,570	8	0.64	4,200	2.20	14,500	2.84	18,700	2.20	14,500	8	0.96	6,300	3.16	20,800	4.12	27,100	4.12	27,100
County	2,482	30	2.40	6,000	2.20	5,500	4.60	11,500	-	64,700	30	2.40	6,000	8.38	20,800	10.78	26,800	10.79	26,800
Total	36,208		1.63*	59,200	2.20*	79,800	3.83*	139,000	3.83*	139,000		1.06*	38,400	3.49*	126,400	4.55*	164,800	4.55*	164,800
Southeast																			
A Gilbert	2,482	23	1.84	4,600	1.60	4,000	[illegible]	8,600	1.60	4,000	8	0.96	2,400	8.38	20,800	9.34	23,200	9.34	23,200
Chandler	16,425	18	1.44	23,700	1.60	26,300	[illegible]	50,000	1.60	26,300	8	0.96	15,800	2.50	41,100	3.46	56,900	3.46	56,900
Tempe	32,850	13	1.04	34,200	1.60	52,600	2.64	86,800	2.64	86,800	8	0.96	31,500	2.50	82,100	3.46	113,600	3.46	113,600
County	1,643	6	0.48	800	1.60	2,600	2.08	3,400	-	31,700	6	0.48	800	12.65	20,800	13.13	21,600	13.13	21,600
Total	53,400		1.18*	63,300	1.60*	85,500	2.78*	148,800	2.78*	148,800		0.94*	50,500	3.08*	164,800	4.02*	215,300	4.02*	215,300
B Gilbert	2,482	29	2.32	5,800	1.60	4,000	3.92	9,800	1.60	4,000									
Chandler	16,425	30	2.40	39,400	1.60	26,300	4.00	65,700	1.60	26,300									
Tempe	32,850	5	0.40	13,100	1.60	52,600	2.00	65,700	2.00	65,700									
County	1,643	10	0.80	1,300	1.60	2,600	2.40	3,900	-	49,100									
Total	53,400		1.11*	59,600	1.60*	85,500	2.71*	145,100	2.71*	145,100									
C Gilbert	2,482	25	2.00	5,000	2.20	5,500	4.20	10,500	2.20	5,500									
Chandler	16,425	26	2.08	34,200	2.20	36,100	4.28	70,300	2.20	36,100									
Tempe	32,850	7	0.56	18,400	2.20	72,300	2.76	90,700	2.76	90,700									
County	1,643	14	1.12	1,800	2.20	3,600	3.32	5,400	-	44,600									
Total	53,400		1.11*	59,400	2.20*	117,500	3.31*	176,900	3.31*	176,900									
D Gilbert	2,482	23	1.84	4,600	1.40	3,500	3.28	8,100	1.40	3,500									
Chandler	16,425	24	1.92	31,500	1.40	23,000	3.32	54,500	1.40	23,000									
Tempe	32,850	23	1.84	60,400	1.40	46,000	3.24	106,400	3.24	106,400									
Scottsdale & Mesa	146,400	-	-	-	-	-	-	-	-	-									
County	1,643	28	2.24	3,700	1.40	2,300	3.64	6,000	-	42,100									
Total	199,800		1.87*	100,200	1.40*	74,800	3.27*	175,000	3.27*	175,000									

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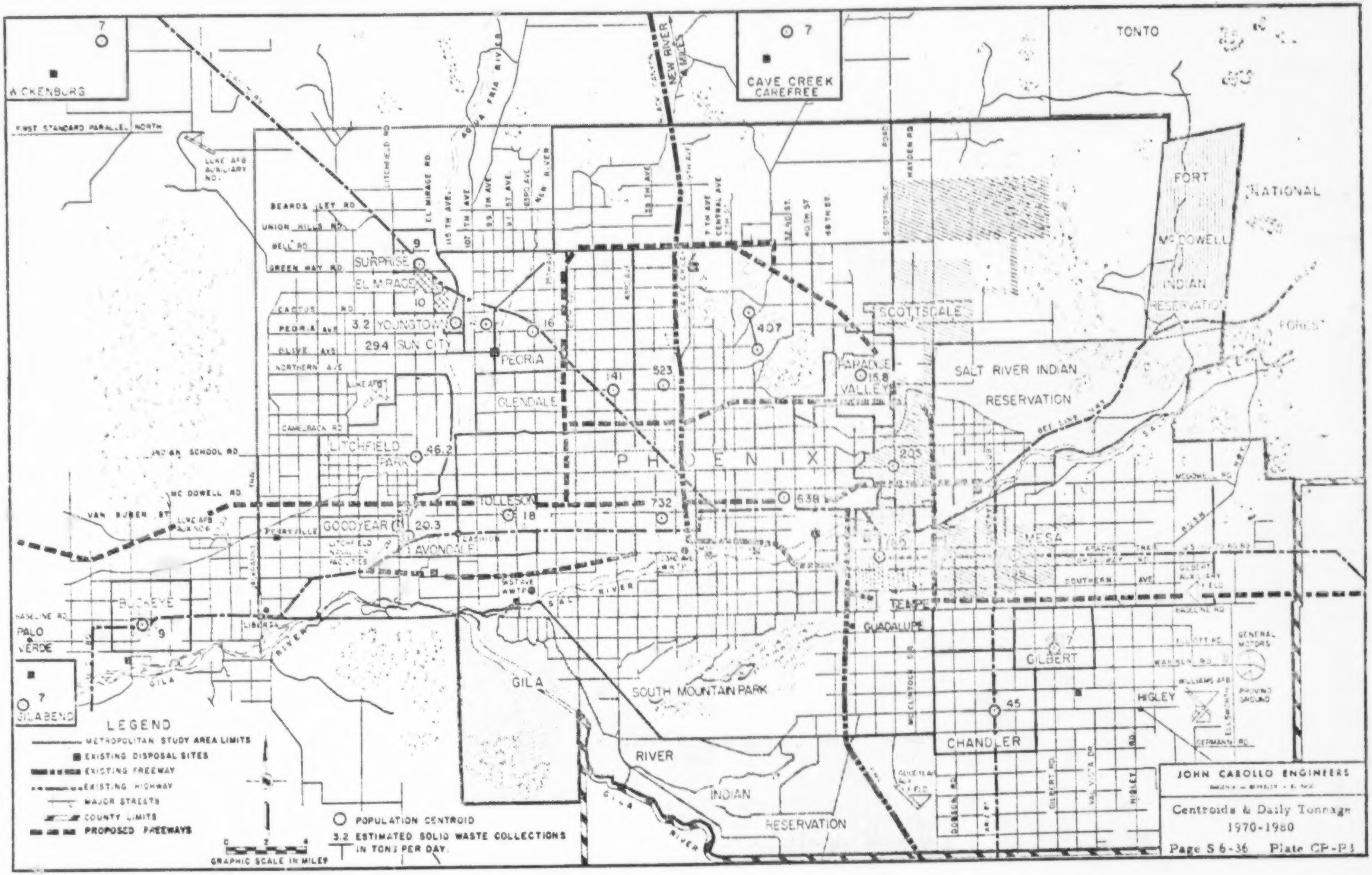
* Indicates average unit costs or payment for considered communities not including Scottsdale and Mesa.

Col. 4 Col. 3 times $0.05 on highways; Col. 3 times $0.08 on County roads.
Col. 5 Col. 2 times Col. 4 to nearest $100.
Col. 6 From Plate CP-P1 (Page S 6-30) plus $0.50 per ton for land.
Col. 7 Col. 2 times Col. 6 to nearest $100.
Col. 8 Col. 4 plus Col. 6.
Col. 9 Col. 5 plus Col. 7.
Col. 10 Col. 6 for Minor Cities and Towns; Col. 8 for Tempe.
Col. 11 Col. 7 for Minor Cities and Towns; Col. 9 for Tempe. For County in Southwest and West Central, total of Col. 5 plus County costs of Col. 7. For County in Southeast, total of Col. 5 less Tempe plus County costs of Col. 7.
Col. 13 Repeat Col. 4 for County; Col. 12 times $0.12 for others.
Col. 14 Col. 2 times Col. 13.
Col. 15 From Plate CP-P1 (Page S 6-30) plus $0.50 per ton for land for Tempe, Chandler, and Litchfield Park; Col. 16 divided by Col. 2 for others.
Col. 16 Col. 2 times Col. 15 for Tempe, Chandler, and Litchfield Park; $20,800 for others.
Col. 17 Col. 13 plus Col. 15.
Col. 18 Col. 14 plus Col. 16.
Col. 19 Repeat Col. 17.
Col. 20 Repeat Col. 18.



WICKENBURG
7
CAVE CREEK
CAREFREE
7
TONTO
NATIONAL
FOREST
FORT
McDOWELL
INDIAN
RESERVATION
FIRST STANDARD PARALLEL NORTH
LUKE AFB AUXILIARY NO. 1
NEW RIVER
AGUA FRIA RIVER
BEARDSLEY RD
UNION HILLS RD
BELL RD
GREEN WAY RD
CACTUS RD
PEORIA AVE
OLIVE AVE
NORTHERN AVE
CAMELBACK RD
INDIAN SCHOOL RD
MC DOWELL RD
VAN BUREN ST
LITCHFIELD RD
EL MIRAGE RD
115 TH AVE
107 TH AVE
99 TH AVE
91 ST AVE
83RD AVE
7 TH AVE
CENTRAL AVE
32 ND ST
40TH ST
48TH ST
SCOTTSDALE ROAD
HAYDEN RD
SURPRISE
9
EL MIRAGE
10
YOUNGTOWN
3.2
SUN CITY
29.4
16
PEORIA
GLENDALE
141
523
407
SCOTTSDALE
PARADISE VALLEY
15.8
SALT RIVER INDIAN
RESERVATION
LUKE AFB
LITCHFIELD PARK
46.2
PHOENIX
203
638
732
TOLLESON
18
GOODYEAR
20.3
AVONDALE
LITCHFIELD NAVAL AIR FACILITIES
PERRYVILLE
LUKE AFB AUX NO. 4
CASHION
BUCKEYE
9
PALO VERDE
HASELINE RD
LIBERTY
GILA BEND
7
SALT RIVER
GILA RIVER
GILA
SOUTH MOUNTAIN PARK
RIVER
INDIAN
RESERVATION
TEMPE
MESA
GUADALUPE
CHANDLER
45
GILBERT
7
HIGLEY
BEE LINE HWY
APACHE
SOUTHERN AVE
GILBERT AUXILIARY FIELD
BASELINE RD
ELLIOTT RD
WARNER RD
WILLIAMS AFB
GENERAL MOTORS PROVING GROUND
ELLSWORTH
GERMANN RD
MC CLINTOCK DR
DOBSON RD
ARIZ 87
GILBERT RD
VAL VISTA DR
HIGLEY RD
LEGEND
METROPOLITAN STUDY AREA LIMITS
EXISTING DISPOSAL SITES
EXISTING FREEWAY
EXISTING HIGHWAY
MAJOR STREETS
COUNTY LIMITS
PROPOSED FREEWAYS
POPULATION CENTROID
3.2 ESTIMATED SOLID WASTE COLLECTIONS IN TONS PER DAY
0
2
4
GRAPHIC SCALE IN MILES

JOHN CAROLLO ENGINEERS

Centroids & Daily Tonnage

1970-1980

Page S 6-36 Plate CP-P3

Column 9 (Page S 6-35) lists totals for haul and disposal costs by regional operation. Annual cost to haul and dispose of Gila Bend's wastes is estimated to be $15,400 and Buckeye's, $13,500. Their present disposal payments are negligible. Annual per capita increased payment of about $6.15 by Gila Bend and $3.86 by Buckeye may not be feasible.

Columns 10 and 11 reflect a suggestion that County funds be appropriated to aid in the solution to a problem affecting that part of the region not in the two communities. Where the County pays all haul costs and shares disposal costs on a per capita basis, Gila Bend's annual payment would be about $7,700 or $3.00 per capita annually. Buckeye's annual payment would be about $10,200 or $3.00 per capita annually. $3.00 per capita annually amounts to $12.00 annually for a family of four. Thus an average family would pay about $1.00 per month for solid wastes disposal.

WEST CENTRAL REGION: The west central region encompasses the urban areas of Goodyear, Avondale, Litchfield Park, Tolleson, and the nearby part of the County. Combined population contributing to production of solid wastes in this region is expected to reach about 27,000 by 1970 and about 68,000 by 1980.

The Agua Fria River slants south-southwesterly through this area, has eroded land along both banks for six miles from Indian School Road to Broadway, and has provided potential sanitary landfill sites within short haul distance for the region. A site near the intersection of El Mirage Road and McDowell Road would be about optimum. Average haul distance would be about eight miles round trip. At $0.08 per ton-mile average haul cost would be $0.64 per ton. Disposal cost would be about $2.20 per ton. Haul and disposal cost would be about $2.84 per ton for each of the four communities. Small urban areas could benefit from this regional disposal program including:

Urban Area	Round Trip Haul Distance	Estimated Cost		
		Haul	Disp.	Total
	(Miles)	$	$	$
Cashion	6	0.48	2.20	2.68
Litchfield N. A. F.	8	0.64	2.20	2.84
Norton	16	1.28	2.20	3.48
Liberty	22	1.76	2.20	3.96
Perryville	20	1.60	2.20	3.80

Costs for two alternate programs for the west central region are included in Table CP-T4 (Page S 6-35).

One alternate is a regional program using a sanitary landfill site in a buffer zone proposed around the Phoenix 91st Avenue Sewage Treatment Plant. Disposal costs do not include tonnage from Phoenix. Thus these costs also apply to the present site of the Tolleson dump. Were Phoenix to be included in this program, the increased tonnage would be expected to result in lower disposal costs for each participating agency.

The second alternate is based upon each of four cities and the County operating separate sanitary landfill disposal sites with haul limited to four miles one way.

Haul and disposal cost is less by regional operation than by individual operation, except for Litchfield Park which has a 26-mile round trip haul to 91st Avenue and Southern Avenue. The unit haul and disposal cost for this region with a disposal site near El Mirage and McDowell Roads was estimated to be about $2.84 per ton. Only Tolleson can do as well by regional plan at 91st Avenue and Southern Avenue. These costs demonstrate the need for a west central regional plan with a disposal site near El Mirage and McDowell Roads.

SOUTHEAST REGION: The southeast region includes urban areas of Gilbert, Chandler, Tempe, and that part of the County. Guadalupe, Higley, and Kyrene are included in the County urban areas.

Costs of four alternate regional plans are compared with costs of individual plans in Table CP-T4 (Page S 6-35).

Four alternate disposal sites are considered, one for each of the alternate regional plans. Alternate disposal site locations and characteristics are as follows:

Plan	Location of Disposal Site	Topography	Tonnage Basis Tons/Yr	Estd Disposal Cost $/Ton
A	Interstate 10 near Warner Rd	Pit	53,400	1.60
B	48th Street near Broadway Rd	Pit	53,400	1.60
C	Hayden Road near Salt River	Gullies*	53,400	2.20
D	McDowell Road near Country Club Drive	Gullies	199,800	1.40

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*Not based on assumption that an existing pit is available.

Southeast B has the lowest estimated annual and unit costs of the five alternate plans, but Southeast A is not significantly higher. Regional alternates A, B, C, and D are less expensive than individual plans. Haul and disposal costs for each regional operation are less for each agency except Chandler. Under Southeast B and Southeast C Chandler's costs would be \$4.00 and \$4.28, respectively, per ton. By individual operation Chandler's cost would be \$3.46 per ton.

Tempe would provide about sixty percent of the tonnage base for plans A, B, and C. Tempe's unit costs would be:

Site	\$ per Ton
A	2.64
B	2.00
C	2.76
D	3.24

Tempe's self interest is in continuing their present operations and establishing one new site. A site along the Salt River between 48th Street and Hayden Road is near optimum in the early 1970's. As development extends southerly, site B at 48th Street and Broadway Road will become progressively better as a duplicate site to minimize haul cost.

Chandler, Gilbert, and the County have, during this study, completed a separate study of their present disposal site and determined the expected life to be about ten years, or nearly through the 1970-1980 decade. With a weighted average haul of 9.6 miles, round trip, and a unit cost of \$0.08 per ton-mile, the average unit haul cost would be \$0.77 per ton. Sanitary landfill disposal cost is estimated to be \$2.80 per ton based on 20,000 tons per year. Haul and disposal for Chandler and Gilbert is estimated to be \$3.55 per ton at this site in 1975.

Chandler and Gilbert are committed to their present site until at least 1975, while Tempe does not benefit from C and D plans in the decade 1970-1980. After 1975 Chandler and Gilbert prefer site A. Therefore it would be to their mutual long-range interest for Tempe, Chandler, and Gilbert to secure control of site A now for use after 1975.

NORTHWEST REGION: The northwest region includes the urban areas of Glendale, El Mirage, Surprise, Peoria, Youngtown, Sun City, Luke Air Force Base, and that part of the County. The combined population contributing solid wastes from the northwest region was estimated to be 79,000 in 1970 and 134,000 in 1980 with an average for the decade of about 106,500. Paradise Valley may continue to cooperate in this regional program and that would raise the decade average contributing population to about 113,500 persons. Estimated average production of solid wastes for Sun City and Youngtown was 32.5 tons per day at a unit rate of 2.5 pounds per day per capita. Estimated average production of solid wastes for other urban areas in the northwest region was 181.5 tons per day at a unit rate of 4.5 pounds per capita per day. For Luke AFB 4 tons per day were estimated. With Paradise Valley contributing about 6 tons per day the average loading rate for sanitary landfills would be about 238 tons per day, or about 87,000 tons annually.

At 7,000 tons per gross acre, the northwest region would be expected to fill a disposal site area at a rate of 12 acres per year. During the 1970-1980 decade this rate would require 120 acres.

Optimum location for a disposal site in the northwest region is near 107th Avenue and Northern Avenue in the interest of minimizing haul cost.

Estimated costs for haul and disposal under these conditions are as follows:

NORTHWEST REGION COST ESTIMATES, 1970-1980

Community (1)	Haul Dist Mi (2)	Haul Cost $/Ton (3)	Disposal Cost $/Ton (4)	Annual Tonnage 1,000 Tons (5)	Haul and Disposal Costs Avg Unit $/Ton (6)	Haul and Disposal Costs Avg Annual $ (7)
Glendale	14	1.12	1.40	52	2.52	131,040
El Mirage	11	0.88	1.40	4	2.28	9,120
Surprise	15	1.20	1.40	3	2.60	7,800
Peoria	9	0.72	1.40	6	2.12	12,720
Youngtown	6	0.48	1.40	1	1.98	1,980
Sun City	8	0.64	1.40	11	2.04	22,440
Luke AFB	14	1.12	1.40	4	2.52	10,080
Paradise Valley	42	3.36	1.40	6	4.76	28,560

Disposal cost in the tabulation above includes land cost at $0.50 per ton of solid wastes disposed. At a site without land cost estimated disposal cost is $0.90 per ton.

CENTRAL REGION: The central region includes the Phoenix study area and adjacent County area. Combined population contributing to production of solid wastes in this region is expected to reach about 703,000 by 1970 and about 1,040,000 by 1980. The estimated rate of solid wastes production is 5.5 pounds per capita per day in Phoenix and 4.5 outside.

In the decade 1970-1980 estimated solid wastes production is 340,000 tons per year in that part of the Phoenix study area north of Indian School Road and 503,000 tons per year south of Indian School Road.

At 7,000 tons per acre the disposal area required is estimated to be 480 acres for the northern part and 710 acres for the southern part for the decade 1970-1980.

No significant acreage is estimated to be required for solid wastes from the County in the south one-half of the central region. Forty-three acres are estimated to be required for County solid wastes in the north one-half of the central region in the decade 1970-1980.

Table CP-T5 (Page S 6-44) includes land, haul, and disposal factors estimated for the central region at ten different sanitary landfill disposal sites. The most feasible combination of factors is indicated for Sites 9 and 10.

Site 9, within one mile of Central Avenue and the Salt River, may be described as a large pit serving the south one-half of Phoenix at an estimated total cost of $2.14 per ton. First cost is estimated to be $1,424,000. First cost includes land at $4,000 per acre plus $96,000 in site improvements.

The same capacity rate, 7,000 tons per acre, was used for Site 9 as for the others, although a pit would be expected to have substantially more capacity. At 7,000 tons per acre the life expectancy of this site is four years. A typical site on the Salt River was estimated to have capacity for 13,700 tons per acre. At 13,700 tons per acre, Site 9 would have an estimated life of about eight years.

The second most feasible site considered to serve the south one-half of the central region is Site 8. Haul cost is tabulated for the southwest quarter to Site 8, and estimated total unit cost is $2.54 per ton.

Table CP-T5

CENTRAL REGION

ESTIMATED HAUL AND DISPOSAL FACTORS

1970-1980

			Improved Site			First Cost			Haul Factors							
Site No. (1)	Location (2)	Area Acres (3)	Land $/Acre (4)	Improv. $/Acre (5)	Total $/Acre (6)	Total $ (7)	7,000 T/Acre $/Ton (8)	Service Area (9)	Dist. Miles (10)	Cost $/T-Mi (11)	$/Ton (12)	Land and Haul Cost $/Ton (13)	Service Area (14)	Daily Load Rate T/Day (15)	O & M Cost $/Ton (16)	Haul & Disposal Cost $/Ton (17)
1	Northern Ave at 107th Avenue	320	1,500	450	1,950	624,000	0.28	W 1/2	24	0.12	2.88	3.16	W 1/2	1,250	0.65	3.81
2	Bell Road at 67th Avenue	320	1,200	500	1,700	544,000	0.24	W 1/2 N 1/2	24 22	0.10 0.10	2.40 2.20	2.64 2.44	W 1/2 N 1/2	1,250 930	0.65 0.85	3.29 3.29
3	8 Miles N of Bell Road 1/2 Mi W of Black Canyon Frwy	640	600	400	1,000	640,000	0.14	N 1/2	30	0.08	2.40	2.54	N 1/2	930	0.95	3.49
4	4 Miles N of Bell Road 1/2 Mi W of Black Canyon Frwy	380	1,000	500	1,500	570,000	0.21	N 1/2	22	0.09	1.98	2.19	N 1/2	930	0.95	3.14
5	3rd Street at Beardsley Road	480	1,500*	350	1,850	888,000	0.26	N 1/2	17	0.10	1.70	1.96	N 1/2	930	0.95	2.91
6	67th Avenue at Salt River	320	3,500	500	4,000	1,280,000	0.57	SW 1/4	17	0.11	1.87	2.44	SW 1/4	730	0.80	3.24
7	91st Avenue at Salt River	320	2,500*	450	2,950	944,000	0.42	SW 1/4	24	0.10	2.40	2.82	SW 1/4	730	0.80	3.62
8	51st Avenue at Salt River	320	4,000	450	4,450	1,424,000	0.64	SW 1/4	10	0.11	1.10	1.74	SW 1/4	730	0.80	2.54
9	Central Avenue at Salt River	320	4,000	450	4,450	1,424,000	0.64	S 1/2	10	0.11	1.10	1.74	S 1/2	1,370	0.40	2.14
10	19th Avenue at Greenway Road	320	3,000	300	3,300	1,056,000	0.47	N 1/2	12	0.09	1.08	1.55	N 1/2	930	0.85	2.40

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*Estimated value of owned property

Note: First costs do not include interest on invested capital

For Site 8 serving the south one-half of the central region estimated total cost is greater, about $3.25 per ton. This is not indicated in the table.

Site 9 estimated total cost of $2.14 per ton is based on 1,370 tons per day. If this site served the southeast quarter of the central region at 640 tons per day, the estimated unit operating and maintenance cost would be about $0.20 per ton more, or $2.34 per ton.

Site 9 is the most feasible to serve the south one-half of the central region. This large, favorable site is better than separate sites for the southwest quarter and the southeast quarter.

Site 10 is the most favorable of those sites considered to serve the north one-half of the central region. Average haul and disposal cost is estimated to be $2.40 per ton in the decade 1970-1980. This includes an allowance for improved land cost of $3,300 per acre. The second most feasible side is Site 5. At $2.91 per ton the estimated unit haul and disposal cost is $0.51 per ton more expensive than at Site 10. At 7,000 tons per acre the land at Site 10 is estimated to cost more than $6,800 per acre when Sites 5 and 10 were equally feasible.

Sites 9 and 10 were estimated to represent average haul costs of $1.10 and $1.08 per ton, respectively. Two cents per ton, the difference, would amount to $46.00 per average day. Over ten years this would amount to $167,900.

Sites 9 and 10 were estimated to represent average disposal costs of $0.40 and $0.85 per ton, respectively. Forty-five cents per ton, the difference, would amount to $1,035 per average day. Over ten years this would amount to $3,767,750.

In the decade 1970-1980, 1,233 acres were estimated to serve the central region. The difference in disposal cost represented by land characteristics of alternate sites was estimated to be $3,767,750. This is a differential of about $3,000 per acre. The lower disposal cost included land and improvements at $4,450 per acre. Therefore $7,450 per acre is not unreasonable for the most favorable site. Where more than 7,000 tons per acre may be disposed, $7,450 per acre may not be the limit of reasonable cost.

It is evident that the analysis above, of haul and disposal costs, was based upon limited records. Computations based upon these limited records are not adequate basis for commitment of the central region to specific land purchases and system design for a decade. Detailed and expanded engineering study of current methods and costs is needed. Detailed analysis of alternate disposal sites promises great savings at a cost equal to a very small percentage of the savings. Great effort may profitably be expended on acquisition of disposal sites with favorable location and topography.

True land first cost will include interest on invested capital. Land cost chargeable to sanitary landfill will be true first cost less land value for the land's ultimate purpose.

WICKENBURG REGION: The Wickenburg region includes Wickenburg, Aguila, and the nearby part of Maricopa County.

Wickenburg is one of the communities isolated in distance from major population centers in the County. Wickenburg's population of about 2,450 is not expected to exceed 2,500, as an average, in the decade 1970-1980.

Maricopa County population in the Wickenburg area is limited to farming, ranching, and tourism.

Production of solid wastes in the Wickenburg study area is estimated to average 7 tons per day in the decade 1970-1980. In sanitary landfill at 7,000 tons per acre this would require 4 acres of land for the decade. The County needs in the region, including agricultural wastes, are estimated to require another 4 acres. The total estimated landfill site area for the decade is 8 acres.

A low tonnage rate, 10 to 20 tons per working day, is estimated for this landfill site. The minimum cost of operating a sanitary landfill was estimated to be $400 per week. At an average 15 tons per working day the estimated disposal cost is $5.33 per ton. At 10 tons per working day, the low range estimate, the unit disposal cost is estimated to be $8.00 per ton. These unit disposal costs are excessive in relation to estimated costs for other regions in the County.

Haul distance from Aguila to Wickenburg or from Wickenburg to Aguila is 50 miles round trip. At $0.07 per ton-mile estimated haul cost is $3.50 per ton. At Aguila the County operates a small landfill.

Disposal equipment cost can be reduced by combining other Wickenburg public work in a program to distribute equipment cost over more work. With collections scheduled for disposal operations on half days for three days per week the dozer would be charged to disposal operations 15 percent of a 5-day week. Fifteen percent of $400 is $60, the weekly disposal cost. At the present rate of disposal, 25 tons per week, the unit disposal owning and operating cost would be $2.40 per ton.

Haul on a once-per-week basis from Aguila, Wittman, and Morristown on a one-man County truck would represent a 150-mile round trip with the truck based in Phoenix. At $0.03 per ton-mile, haul cost would be $4.50 per ton for full loads. Partial loads would cost more per ton. Three-ton loads on a one-man truck based in Wickenburg would result in lower estimated haul cost, $3.45 per ton.

The Wickenburg region can be served by one collection packer truck and one dump bed truck hauling for the region to a central sanitary landfill disposal site operated by Wickenburg. County payment for all haul cost plus County share of disposal cost would correspond to proposed financing of a program for the southwest region.

The tabulation below summarizes first cost and payment elements to be considered for the program:

WICKENBURG REGION

ESTIMATED FIRST COST ELEMENTS

1970-1980

	First Cost			Payment	
	Haul	Disposal	Total	Wickenburg	County
	$	$	$	$	$
Land, 40 acres		12,000	12,000		12,000
Improvements		6,000	6,000		6,000
Equipment	16,000	20,000	36,000	36,000	
Total	$16,000	$38,000	$54,000	$36,000	$18,000

The next tabulation, below, summarizes equipment owning and operating cost factors:

WICKENBURG REGION
EQUIPMENT OWNING AND OPERATING COST FACTORS
1970-1980

	Program Time Days/wk (1)	First Cost (2)	O & O Cost (3)	Disposal Cost (40 ton/week)		Collection & Haul Cost (40 ton/wk)		Other Public Works $/wk (8)
				$/wk (4)	$/ton (5)	$/wk (6)	$/ton (7)	
		$	$	$	$	$	$	$
Dozer	1.5	20,000	400	60	1.50			340
Garbage Truck	5	11,000	300			300	10.00	0
Dump Bed Truck	2	5,000	300	—	—	120	12.00	180
Total		$36,000	$1,000	$60	$1.50	$420	$10.50	$520

Haul in a packer truck from Wickenburg, 6 miles round trip, at $0.12 per ton-mile would cost $0.72 per ton. Haul in a dump bed truck from Wickenburg, 6 miles round trip, at $0.30 per ton-mile would cost $1.80 per ton. The estimated average unit haul cost for both kinds of solid wastes is $0.87 per ton. This estimate is based on 4 tons per week by dump truck and 26 tons per week by packer truck.

County haul in a packer truck from Aguila, 50 miles round trip, at $0.07 per ton-mile would cost $3.50 per ton. County haul in a dump bed truck from Aguila, 50 miles round trip, at $0.25 per ton-mile would cost $12.50 per ton. The estimated average unit haul cost for both kinds of solid wastes is $5.10 per ton.

Providing Maricopa County and Wickenburg can use the dozer on other public works 3.5 days per week and the dump truck 3 days per week, haul and disposal costs are estimated to be:

	Haul $/ton	Disposal $/ton	Total $/ton
Wickenburg	0.87	1.50	2.37
County	5.10	1.50	6.60

Close cooperation between Wickenburg and Maricopa County is required to attain these unit costs. Careful program planning is necessary.

NORTHEAST REGION: The northeast region includes the urban areas of Scottsdale, Mesa, Salt River Indian Reservation, and adjacent County area. It may also include Paradise Valley and the Cave Creek-Carefree area between 1970-1980, although Paradise Valley was included in the northwest region (to correspond to present operations), and the Cave Creek-Carefree area was included in the central region with Phoenix.

The average population forecast for Scottsdale in the decade 1970-1980 was 90,000 persons and for Mesa, 83,000 persons. The northeast region is expected to produce residential, commercial, and industrial solid wastes at a rate of 4.5 pounds per capita per day. In Table CP-T3 (Page S 6-27) an estimated land area requirement for this region is indicated to be 274 acres for the decade 1970-1980.

The population centroid for Mesa and Scottsdale, combined, is within one mile of the Salt River at Dobson Road. In relation to existing haul roads and potential landfill sites, near optimum sites lie along the Salt River north bank between Country Club Drive and McClintock Drive.

In Table CP-T3 (Page S 6-27) the estimated land area required for northeast region disposal sites by the year 2000 is indicated to be 1,145 acres or 1.79 square miles. Great potential benefit can be realized by programming and completing land reclamation of this acreage. Improvement of the Salt River channel should be considered in the land use study on which programming is based.

The Salt River Pima-Maricopa Indian Community has made notable improvements in their disposal operations in 1967. All of the good features of a modern sanitary landfill operation can be maintained in this area by this Indian Community. All participants in the program can benefit economically while improving their central area.

Disposal cost estimates for the northeast region are based upon average site topography (Plate CP-P1, Page S 6-30). Average disposal site loading rate for this region is estimated at 500 tons per day. This estimate is composed of three elements: Mesa, 230; Scottsdale, 238; and Maricopa County, 32 tons per day. On Plate CP-P1 the estimated disposal cost, less land, is $1.00 per ton. Land rental is now at a rate of $0.05 per cubic yard as received. Density in Mesa and Scottsdale trucks is about 480 pounds per cubic yard. Therefore present cost for land is estimated to be $0.21 per ton. Total disposal cost is estimated to be $1.25 per ton in the 1970-1980 decade for Mesa and Scottsdale. The same rate is used for Maricopa County, on a weight basis, although the load density would affect the charge on the present billing basis.

Haul cost factors in the tabulation below are based upon location of a disposal site one mile southwesterly from the present site on the

Salt River north bank. Disposal cost is estimated at $1.25 per ton.

NORTHEAST REGION

ESTIMATED HAUL AND DISPOSAL COSTS, 1970-1980

	Round Trip Haul			Haul and Disposal Cost
	Distance	Cost		
Place	Miles	$/ton-Mi	$/ton	$/ton
(1)	(2)	(3)	(4)	(5)
		$	$	$
Mesa	15	0.06	0.90	2.15
Scottsdale	10	0.06	0.60	1.85
Paradise Valley	22	0.12	2.64	3.89
Maricopa County				
Cave Creek area	64	0.10	6.40	7.65
U.S. Highway 60 strip*	27	0.10	2.70	3.95

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* Centroid at Higley Rd and Apache Trail, 6 miles east of Mesa centroid.

The Cave Creek area disposal cost in the central region was estimated to be $0.47 per ton for land, $0.85 per ton for operations, and $1.32 per ton, total. Haul would be 44 miles round trip. At $0.12 per ton-mile, haul cost would be $5.28 per ton. Estimated haul and disposal cost would be $6.60 per ton.

Estimated haul and disposal costs for the Cave Creek-Carefree area are $6.60 per ton in the central region and $7.65 per ton in the northeast region. It is significantly less expensive for this County area to be included in the central region program.

COUNTY GOVERNMENT PARTICIPATION IN REGIONAL PROGRAMS

Maricopa County through the Maricopa County Health Department, Division of Environmental Services provides inspection and sanitary control service relating to solid wastes collection and disposal. This Division should continue to give positive leadership in improving collection, haul, and disposal services throughout Maricopa County.

This Division also cooperates with communities in providing disposal sites and services near Gila Bend, Cave Creek, Palo Verde, and Aguila. This Division shares disposal costs with larger cities in proportion to the amount of solid wastes received at their sites from nearby areas within Maricopa County.

At Guadalupe, an unincorporated community, the County provides large containers, spaced throughout the area, for temporary storage of solid wastes. Tempe collects from these containers and disposes of the wastes in their sanitary landfill at County expense.

This variety of services indicates recognition of the regional nature of solid wastes problems and a unique effort to solve them. It is now proposed that Maricopa County enlarge the program with the following purposes:

1. Provide leadership in establishing sanitary landfill operations for use of Gila Bend, Wickenburg, Buckeye, Tolleson, Avondale, Goodyear, Litchfield Park, Chandler, and the Cave Creek-Carefree-New River area.

2. Provide for these operations within regional programs at central disposal sites to minimize overall costs and establish adequate sanitary control.

3. Provide specialized long-haul equipment to establish feasible haul costs from more remote collection areas.

4. Provide for more complete collection of solid wastes in smaller residential areas along haul routes.

5. Provide for sanitary disposal of hazardous agricultural solid wastes at regional sanitary landfills as an alternate to prompt burial on site.

6. Provide for interim disposal improvements between 1968 and 1970 as follows:

a. Tolleson would join Avondale, Goodyear, Litchfield Park, and Maricopa County in attaining sanitary landfill conditions at the Avondale site.

b. Carefree, Cave Creek, and New River solid wastes would be hauled to the Phoenix 19th Avenue sanitary landfill. The Cave Creek landfill would be closed.

c. Buckeye would haul to the County landfill at Palo Verde. The Buckeye burning dump would be closed.

d. Aguila and Wickenburg would cooperate in sanitary landfill disposal at a new site west of Wickenburg.

e. Maricopa County's small dozer would be limited to a work program commensurate with its size at Gila Bend and Palo Verde landfills on a daily basis for each site.

Provision 6 above may be within the present capacity of the Division of Environmental Services. Provisions 1 through 5 above would require additional staff, equipment, management, and funds. Staff, management, and equipment required would be in the public works field, primarily, rather than environmental health services. Present efforts are authorized in Section 11-251, Sub-Section 17 (Page S 5-19). The proposed major increase in Maricopa County services would, preferably, be based upon new, more specific, enabling legislation.

This Report does not contemplate a complete public works department at the County level as that could include water works, sewerage works, and other responsibilities not included in the scope of this study. Recommended functions of the new subdivision of County government would be limited to cooperation and leadership in regional programs for haul and disposal of solid wastes. Revenue to support an increased County effort in solid wastes haul and disposal must come from County resources. Some Federal funds might be available in the development stage as one or more demonstration projects in a regional long-haul program and development of basic data related to wastes production in dispersed areas. Although aid in demonstration projects would be expected to have little effect on long-term revenue in support of a regional program, the findings could, possibly, result in more efficient operations and less long-term cost.

MEANS FOR EXTENDING COLLECTION AREAS

The proportion of Maricopa County land area provided with solid wastes collection service is very small. But a very large proportion has no need for collection service, including nearly uninhabited desert and mountainous areas of State and Federal lands.

Residential solid wastes in some agricultural areas are too dispersed for collection at reasonable cost. Residential solid wastes in some nonincorporated urban areas are less dispersed, allowing collection at reasonable cost. One example of this is Sun City where individual householders pay directly to a private collector.

Commercial and industrial accounts in Phoenix support the collection efforts of full time private collectors, but in Gila Bend they do not.

The population density has not been determined in this study below which collection is not feasible and above which collection is feasible. The critical density for residential collections is somewhere between 0.02 persons per acre (agricultural) and 0.57 persons per acre (Paradise Valley). But other factors affect collection feasibility such as mean annual income, size of service area, frequency of collection, kinds of wastes collected, adequacy of roads, haul distance, and disposal cost. Adequate evaluation of potential collection areas in Maricopa County is beyond the scope of this Report on haul and disposal.

Yet it has been reported that promiscuous dumping is common in urban fringe areas and on-site accumulations in many areas are common. Reported examples of excessive and enduring on-site accumulations of solid wastes have frequently been in low-income neighborhoods. Efforts to attract private collection firms to these potential markets have failed because they expect too many uncollectible accounts.

Some means are available to extend collection services into areas not served now. Where payment is guaranteed by a public agency, private firms will contract collection services on a competitive bid basis. By licensing or franchising to private collectors an area promising adequate, if not complete, payment may be served. By public agency collection, without billing, collection areas may be extended. Each of these concepts have advantages and disadvantages that must be considered for each potential service area.

Competitive bidding for service contracts is a logical approach where performance has been carefully specified and control can be maintained. Where bid prices are considered too high, service elements are indicated to be not feasible. Low first cost is an advantage in this method.

Franchised collection areas would require new enabling legislation in Maricopa County. One purpose of franchised areas for public utilities is to compel service extensions beyond the more profitable core into the less profitable fringe.

Public agency collection is defined here as extension of municipal collection service beyond incorporated limits. No suggestion is intended that Maricopa County engage in the practice of solid wastes collection. Solid wastes collection is more expensive than haul and disposal combined even in densely populated areas where collection effort is most efficient. Solid wastes collection and haul from dispersed populations would be at intolerable expense. House-to-house collection at County expense in an urban County area (Sun City or Guadalupe, for example) could be as efficient as average residential areas. But this precedent could create a demand for equal service, at County expense, to every solid wastes source including all ranches, resorts, recreation areas, hog farms, and cattle pens.

Revenue to support franchised or extra-municipal collection services would be either by County general fund revenues or, in the case of franchised areas, by direct customer billing. One effect of using general fund revenues is to distribute payment for high individual costs over all County taxpayers. One effect of direct customer billing in franchised areas is to distribute payment for high individual costs over residents of the franchised area only. Although the first distribution may seem more equitable, the second is common for franchised public utilities.

1980-1990 SOLID WASTES DISPOSAL PROGRAM

GENERAL: Disposal by sanitary landfill is the basis of the 1980-1990 program. Landfill sites considered in the 1970-1980 program will have been acquired during that decade. Their use will continue into this decade.

Projected populations, rates of solid wastes production, and centroids of collection areas are less reliable for succeeding decades. Programs are, therefore, more general and will require continuing study and review in the late 1970's.

LOCATION OF POTENTIAL LANDFILL SITES: Borrow pits in use between 1970 and 1980 should be operated in a schedule of developing sanitary landfill sites. Long range planning is essential to develop pits favorable for the program. Some developing pits will be located at sites not favorable for solid wastes haul. Total tonnage of borrow will be significant but is not directly comparable to solid wastes tonnage in the same period of time. A ton of solid wastes will replace about three tons of borrow on a volume basis.

An opportunity exists for public works departments to accomplish coordinated programs of earth borrow and solid wastes disposal. Costs of borrow and haul plus costs of solid wastes haul and disposal for alternate borrow sites should be considered before designating a borrow site for use.

Where negotiation for ownership of depleted, private borrow pits fails, condemnation should be considered. Public savings over the life of a site may be very substantial where both haul and disposal costs can be lower as compared to an alternate site.

PROJECTED AMOUNTS OF SOLID WASTES: Estimated population centroids are indicated on Plate CP-P3 (Page S 6-36) for each community and four Phoenix collection areas. Estimated average daily tonnage production at each centroid is indicated for the decade 1980 to 1990. These production rates include residential, commercial, and industrial solid wastes.

Table CP-T6 (Page S 6-60) relates projected disposal area requirements to solid wastes production projections at 24 centroids in the decade 1980 to 1990. Plate CP-P4 (Page S 6-61) indicates locations of centroids and tonnage rates.

In 1967 City of Phoenix personnel had about 2,250 acres in 18 parcels under study as potential disposal sites to serve the south one-half of Phoenix. Seven hundred ten acres were estimated to be required in the 1970-1980 decade. One thousand acres were estimated to be required in the 1980-1990 decade for the south one-half of Phoenix. No shortage of sites is foreseen for the 1980-1990 decade.

In 1967 884 acres in 5 parcels were under study as sites to serve the north one-half of Phoenix. Additional sites along New River and Cave Creek should be considered.

Four hundred eighty acres were estimated to be required by 1980 for the north one-half of Phoenix, and 710 acres in the 1980-1990 decade, for a total of 1,190 acres by 1990.

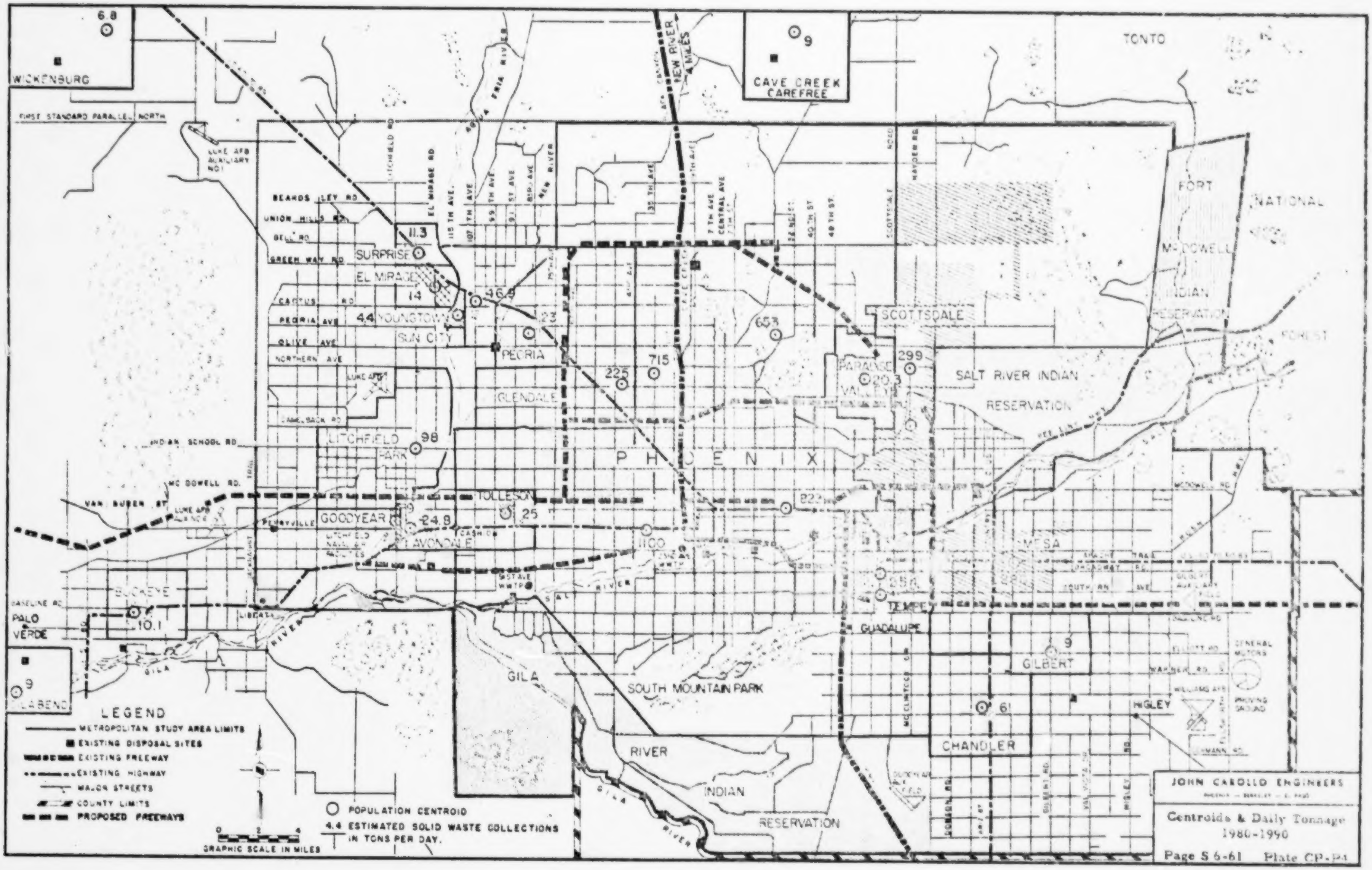
Table CP-T6

PROJECTED DISPOSAL AREA REQUIREMENTS

Sanitary Landfill at 7,000 Tons per Acre

1980 - 1990

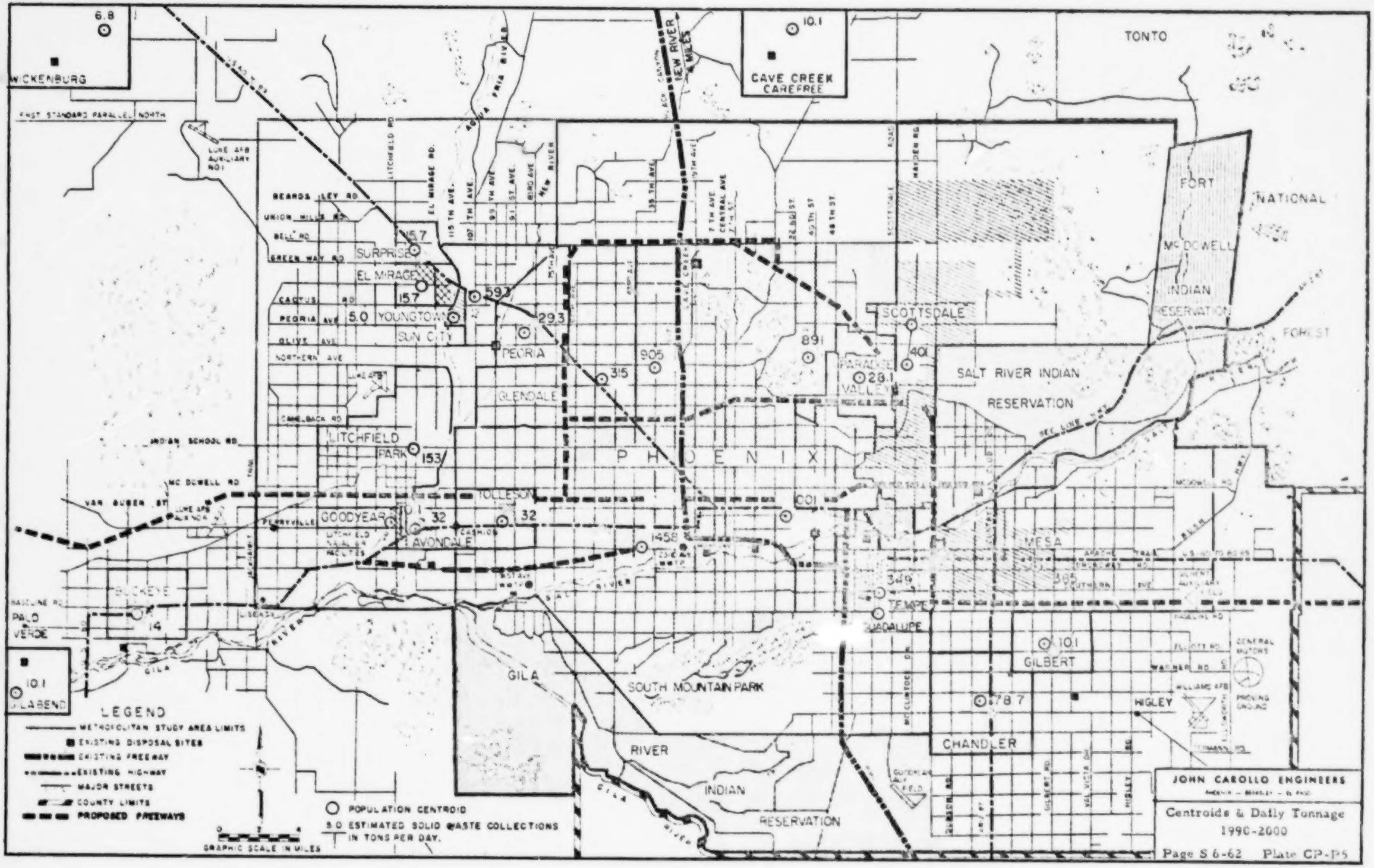
Place	Production Rate 1,000 Tons per Year	Disposal Area Requirements	
		Acres per Year	Acres per 10 Years
(1)	(2)	(3)	(4)
Phoenix	1,205	171	1,710
SE 1/4	299	43	430
NE 1/4	241	34	340
NW 1/4	263	37	370
SW 1/4	402	57	570
Gilbert	3	0.4	4
Chandler	22	3.1	31
Tempe	91	12.9	129
Mesa	99	14.1	141
Scottsdale	106	15.1	151
Paradise Valley	7	1.0	10
Cave Creek	3	0.4	4
Glendale	82	11.7	117
Peoria	8	1.1	11
Sun City	17	2.4	24
Youngtown	2	0.3	3
El Mirage	5	0.7	7
Surprise	4	0.6	6
Wickenburg	3	0.4	4
Tolleson	9	1.3	13
Avondale	9	1.3	13
Goodyear	3	0.4	4
Litchfield Park	36	5.1	51
Buckeye	4	0.6	6
Gila Bend	3	0.4	4
Total			2,443


WICKENBURG
6.8
CAVE CREEK
CAREFREE
9
TONTO
NATIONAL
FOREST
FIRST STANDARD PARALLEL NORTH
LUKE AFB AUXILIARY NO 1
NEW RIVER
4 MILES
AGUA FRIA RIVER
BEARDSLEY RD
UNION HILLS RD
BELL RD
GREEN WAY RD
CACTUS RD
PEORIA AVE
OLIVE AVE
NORTHERN AVE
CAMELBACK RD
INDIAN SCHOOL RD
MC DOWELL RD
VAN BUREN ST
BASELINE RD
LITCHFIELD RD
EL MIRAGE RD
115 TH AVE
107 TH AVE
99 TH AVE
91 ST AVE
83RD AVE
NEW RIVER
35 TH AVE
7 TH AVE
CENTRAL AVE
32 ND ST
40 TH ST
48 TH ST
SCOTTSDALE ROAD
HAYDEN RD
SURPRISE
11.3
EL MIRAGE
14
46.9
4.4
YOUNGTOWN
SUN CITY
123
PEORIA
GLENDALE
225
715
653
SCOTTSDALE
299
PARADISE VALLEY
20.3
SALT RIVER INDIAN
RESERVATION
FORT
McDOWELL
INDIAN
RESERVATION
LITCHFIELD PARK
98
PHOENIX
TOLLESON
25
GOODYEAR
24.8
AVONDALE
LITCHFIELD NAVAL AIR FACILITIES
1100
822
MESA
356
TEMPE
GUADALUPE
GILBERT
9
CHANDLER
61
HIGLEY
WILLIAMS AFB
GENERAL MOTORS PROVING GROUND
BUCKEYE
10.1
PALO VERDE
GILA BEND
9
GILA
RIVER
SOUTH MOUNTAIN PARK
GILA
RIVER
INDIAN
RESERVATION
SALT RIVER
LEGEND
METROPOLITAN STUDY AREA LIMITS
EXISTING DISPOSAL SITES
EXISTING FREEWAY
EXISTING HIGHWAY
MAJOR STREETS
COUNTY LIMITS
PROPOSED FREEWAYS
0 2 4
GRAPHIC SCALE IN MILES
POPULATION CENTROID
4.4 ESTIMATED SOLID WASTE COLLECTIONS IN TONS PER DAY.

JOHN CAROLLO ENGINEERS

Centroids & Daily Tonnage
1980-1990

Page S 6-61 Plate CP-P4


WICKENBURG
6.8
CAVE CREEK
CAREFREE
10.1
TONTO
NATIONAL
FOREST
FORT
McDOWELL
INDIAN
RESERVATION
SALT RIVER INDIAN
RESERVATION
NEW RIVER
4 MILES
FIRST STANDARD PARALLEL NORTH
LUKE AFB AUXILIARY NO1
AGUA FRIA RIVER
NEW RIVER
LITCHFIELD RD
EL MIRAGE RD.
115 TH AVE.
107 TH AVE.
99 TH AVE
91 ST AVE.
83RD AVE
35 TH AVE
19TH AVE
7 TH AVE
CENTRAL AVE
7TH ST
22 ND ST
40 TH ST
48 TH ST
SCOTTSDALE ROAD
HAYDEN RD
BEARDSLEY RD
UNION HILLS RD
BELL RD
GREEN WAY RD
CACTUS RD
PEORIA AVE
OLIVE AVE
NORTHERN AVE
CAMELBACK RD
INDIAN SCHOOL RD
MC DOWELL RD
VAN BUREN ST
BASELINE RD
SURPRISE
15.7
EL MIRAGE
15.7
YOUNGTOWN
5.0
SUN CITY
59.7
29.3
10.1
PEORIA
GLENDALE
905
315
891
SCOTTSDALE
40.1
PARADISE VALLEY
28.1
LUKE AFB
LITCHFIELD PARK
153
PHOENIX
TOLLESON
GOODYEAR
10.1
32
32
AVONDALE
PERRYVILLE
CASHION
1458
100
SALT RIVER
GILA RIVER
MESA
385
349
TEMPE
GUADALUPE
SOUTH MOUNTAIN PARK
GILBERT
10.1
CHANDLER
178.7
HIGLEY
WILLIAMS AFB
GENERAL MOTORS PROVING GROUND
BUCKEYE
14
PALO VERDE
GILA BEND
10.1
GILA
GILA
RIVER
INDIAN
RESERVATION
LEGEND
METROPOLITAN STUDY AREA LIMITS
EXISTING DISPOSAL SITES
EXISTING FREEWAY
EXISTING HIGHWAY
MAJOR STREETS
COUNTY LIMITS
PROPOSED FREEWAYS
POPULATION CENTROID
5.0 ESTIMATED SOLID WASTE COLLECTIONS IN TONS PER DAY.
0
2
4
GRAPHIC SCALE IN MILES

JOHN CAROLLO ENGINEERS

Centroids & Daily Tonnage
1990-2000

Page S 6-62 Plate CP-P5

As control of each disposal site is acquired, a plan for its use should be developed. This will result in a series of capacity estimates which should be accumulated for the program. As solid wastes disposal records accumulate, they should be evaluated to determine any trend in per capita disposal rates and density of solid wastes in place. Continuing review of population projections after the 1970 census will serve to refine those projections. All of these factors are basic factors in programming the 1980-1990 solid wastes disposal plan.

1990-2000 SOLID WASTES DISPOSAL PROGRAM

GENERAL: Disposal by sanitary landfill is expected to be the basis of the 1990-2000 program. Landfill sites are expected to be at greater distances from population centroids in the Metropolitan Study Area as compared to the 1980-1990 program.

Long haul and increased unit haul costs should be expected. A proposed Phase II of this study would consider the relative merits of truck and rail haul, stationary compactors, transfer stations, and remote sanitary landfill sites.

PROJECTED AMOUNTS OF SOLID WASTES: By 1995 this study will be twenty-seven years old. Current estimates of haul and disposal problems for the 1990-2000 decade will be revised during the ensuing years. Estimated solid wastes centroids for this decade are indicated on Plate CP-P5 (Page S 6-62) for each community and four collection areas in Phoenix. Estimated average daily tonnage production at each centroid is indicated for the 1990-2000 decade.

Table CP-T7 (Page S 6-65) relates projected disposal area requirements to solid wastes production projections at 24 centroids in the 1990-2000 decade.

Two thousand two hundred acres are estimated for Phoenix and about 1,000 acres for 20 other communities. Three thousand two hundred twenty-four acres are estimated for all 21 communities.

Two hundred sixty thousand people were expected in the dispersed population of Maricopa County by about 1995. At 4.5 pounds per capita per day 260,000 people would produce 586 tons per day and require about 30 acres per year for sanitary landfill disposal or a total of 300 acres for that decade. This population, 260,000 people, is called "dispersed population" but a substantial part will be in new communities or, possibly, in annexations to present communities but beyond the study area limits assigned for this study. Collection of solid wastes from a substantial part of this "dispersed population" should be expected. Haul and disposal facilities should be planned as part of the County-wide program.

Table CP-T7

PROJECTED DISPOSAL AREA REQUIREMENTS

Sanitary Landfill at 7,000 Tons per Acre

1990 - 2000

Place	Production Rate 1,000 Tons per Year	Disposal Area Requirements	
		Acres per Year	Acres per 10 Years
(1)	(2)	(3)	(4)
Phoenix	1,555	220	2,200
SE 1/4	361	51	510
NE 1/4	329	47	470
NW 1/4	332	47	470
SW 1/4	533	75	750
Gilbert	4	0.6	6
Chandler	28	4.0	40
Tempe	131	18.5	185
Mesa	139	19.6	196
Scottsdale	146	20.6	206
Paradise Valley	11	1.6	16
Cave Creek	4	0.6	6
Glendale	117	16.6	166
Peoria	11	1.6	16
Sun City	22	3.1	31
Youngtown	2	0.3	3
El Mirage	6	0.9	9
Surprise	6	0.9	9
Wickenburg	3	0.4	4
Tolleson	11	1.6	16
Avondale	11	1.6	16
Goodyear	4	0.6	6
Litchfield Park	56	8.0	80
Buckeye	5	0.7	7
Gila Bend	4	0.6	6
Total			3,224

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